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# Biomarkers and clinical outcomes of hospitalized patients with COVID-19

Biomarcadores laboratoriais e desfecho clínico de pacientes hospitalizados com COVID-19

Biomarcadores y resultados clínicos de pacientes hospitalizados con COVID-19

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## ABSTRACT

**Introduction:** This study aims to analyze laboratory biomarkers in patients infected with SARS-CoV-2 in public hospitals in Maranhão and compare the results between those who were discharged and those who did not survive. **Outlining:** This cross-sectional study evaluated a sample of 192 medical records of patients admitted between July and December 2020. The study assessed variables such as sex, age group, race, comorbidities, length of hospital stay, symptoms, medication classes, and clinical biomarkers related to cardiac, hepatic, renal, and coagulation functions. The data were analyzed using SPSS software (version 20.0). **Results:** The participants were predominantly male and above the age of 60, and this age group was significantly associated with a higher risk of death. Symptoms such as fever (OR=3.81) and absence of cough (OR=2.31), as well as the use of sedatives (OR=4.47) and vasoactive drugs (OR=20.14), were found to be significantly associated with an increased risk of mortality. When comparing the biomarkers of patients hospitalized in the ICU who were discharged versus those who died, higher mean values were observed for prothrombin time, activated partial thromboplastin time, D-dimer, urea, creatinine, potassium, leukocytes, PCR, and glucose levels among the deceased patients. Conversely, lower mean levels of albumin were observed in those who did not survive. **Implications:** Therefore, these biomarkers can contribute to the assessment of disease progression and monitoring the health status of patients treated in ICU settings.

## DESCRIPTORS

Biomarkers; Coronavírus; Hospital Care; Public Health.

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## INTRODUCTION

The first cases of patients with an unknown disease were reported by China to the World Health Organization (WHO) on the last day of December 2019. Eight days after the discovery, Chinese researchers isolated SARS-CoV-2, a single-stranded RNA virus belonging to the Coronaviridae family, which causes respiratory diseases in animals and gave rise to Coronavirus Disease-2019 (COVID-19). Prior to 2019, there were already six known viruses within this family capable of causing diseases in humans, making SARS-CoV-2 the seventh one described.[1-2]

COVID-19, the disease caused by the novel coronavirus 2019, rapidly spread across China and the rest of the world, leading the WHO to declare it a pandemic on March 11, 2020. In affected individuals, COVID-19 can trigger severe pneumonia and acute respiratory distress syndrome, often resulting in rapid deterioration and multi-organ failure leading to death.[3] It is believed that SARS-CoV-2 primarily targets the pulmonary endothelium, utilizing the spike protein to enter cells via the angiotensin-converting enzyme 2 (ACE2), which is present not only in the pulmonary endothelium but also in other organs, as well as the vascular endothelium. Viral replication in these sites may contribute to the pathophysiology of microcirculatory alterations observed in SARS-CoV-2 infections.[4]

COVID-19 is currently one of the leading infectious diseases, posing a significant threat to public health and individuals' lives due to its high incidence and infectivity.[5] Disease progression is associated with significant changes in laboratory test results, including hematological and hemostatic parameters such as elevated leukocyte and D-dimer levels. These alterations have been linked to higher mortality rates and worsening of the infection, with a progressive escalation observed. Additionally, differences in biochemical markers such as cardiac troponin, albumin, aminotransferases, creatinine, and acute-phase proteins like C-reactive protein have been observed.[6-7]

Laboratory support plays a critical role in the early detection, diagnosis, and treatment of many diseases, and COVID-19 is no exception. Laboratory diagnostics go beyond basic diagnosis and epidemiological surveillance, enabling virus identification. In vitro diagnostic tests are frequently employed to classify disease severity, define prognosis, monitor patient health status, guide treatment decisions, and facilitate therapeutic monitoring.[8]

Given that laboratory tests are essential for evaluating, screening, diagnosing, and prognostic monitoring in the context of human physiological alterations, they are crucial for identifying biomarkers that can help predict severe disease progression and guide clinical treatment decisions. Therefore, our study aims to analyze cardiac, hepatic, renal, coagulation, and clinical biomarkers in hospitalized patients with SARS-CoV-2 infection and compare them based on discharge or mortality outcomes.

## METHOD

This study employed a cross-sectional, analytical design with a quantitative approach and was conducted in two municipalities, Caxias and Presidente Dutra, in the state of Maranhão, Brazil. The study utilized epidemiological data from the second quarter of 2020. Caxias, located in the eastern region of Maranhão, has an estimated population of 166,159 inhabitants in 2021[9], while Presidente Dutra, situated in the central-eastern region of the state, has an estimated population of 48,264 inhabitants in 2021.[9]

The use of an Informed Consent Form was waived; however, the research team signed a Data Utilization Commitment Form. The project was submitted to the Research Ethics Committee (CEP) of the participating institutions and health services and subsequently to the Plataforma Brasil. Approval was obtained from CEP-UEMA, CAAE: 38579520.8.0000.5554, under opinion number:

4,356,353, dated October 22, 2020, in compliance with the recommendations of Resolution No. 466/12 of the National Health Council.

Data were collected from hospitals within the state health system that serve as reference centers for the health macro-regions of the state. The sample comprised 192 medical records of patients aged 18 years and above who were hospitalized between July and December 2020. A checklist was used for data collection, capturing information on the tests conducted during the hospitalization period, as well as sociodemographic data, vital signs, symptoms, and medications. Medical records were selected through simple random sampling. Medical records of patients who were discharged or died within 24 hours of hospitalization were excluded due to insufficient data for analysis. Similarly, medical records of patients transferred to other hospitals were excluded due to the inability to evaluate outcomes.

Data analysis involved standard descriptive statistics, including absolute frequency (n) and relative frequency (%), means, and standard deviation. Bivariate analysis employed the chi-square test and Fisher's exact test. The strength of association between the independent variable and the dependent variable (discharge or death outcome) was assessed using Binary Logistic Regression, presenting crude Odds Ratios (OR) with a 95% confidence interval (CI). Collinearity testing was performed to identify multicollinear variables.

An independent samples t-test was conducted to compare the means of laboratory test results between non-survivors and survivors. The normality of data distribution was assessed using the Kolmogorov-Smirnov test, while the assumption of variance homogeneity was evaluated using Levene's test. Bootstrapping procedures involving 1000 re-samplings and 95% bias-corrected and accelerated confidence intervals (BCa CI) were employed to address deviations from normality in the sample distribution and account for group size differences.[10] Cohen's d was used to calculate the effect size between the means of the two groups. (11 Data analysis was performed using SPSS software version 20.0, and the significance level was set at $p \leq 0.05$.

## RESULTS

A total of 192 medical records of COVID-19 patients admitted to ICU beds in two regional public hospitals managed by the Maranhão Hospital Services Company (EMSERH) were analyzed. The analysis focused on the clinical outcomes of discharge or death, as well as the patients' sociodemographic profiles, comorbidities, symptoms, and medication classes used.

Table 1 reveals that there was no significant difference in mortality between males and females (OR=0.75, 95% CI 0.37-1.50, p=0.415). However, age group showed a significant association, with individuals aged 60 and above having a higher likelihood of death from COVID-19 compared to those below 60 years old (OR=2.60, 95% CI 1.28-5.28). Race did not demonstrate a significant association with the death outcome (p=0.556). The variable representing functional activity, which included actively employed individuals and retirees, exhibited multicollinearity (tolerance value of 0.30 and VIF of 32.970) with the age group variable. Consequently, the decision was made to exclude functional activity from the model.

**Table 1** – Clinical outcome based on the sociodemographic profile of patients receiving intensive care treatment for SARS-CoV-2 infection.

| Variables | Outcome | | | | OR | 95% CI | p-value |
|---|---|---|---|---|---|---|---|
| | Death | | Discharge | | | | |
| | N | % | n | % | | | |
| **Sex** | | | | | | | |
| Male | 90 | (46,9) | 34 | (17,7) | 0,75 | 0,37 - 1,50 | 0,415[a] |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Female | 53 | (27,6) | 15 | (7,8) | 1 | | |
| **Age Group** | | | | | | | |
| Under 60 years | 28 | (14,6) | 19 | (9,9) | 1 | | **0,007**[a] |
| Above 60 years | 115 | (59,9) | 30 | (15,6) | 2,60 | 1,28 - 5,28 | |
| **Race** | | | | | | | |
| White | 9 | (5,1) | 2 | (1,1) | 3,37 | 0,39 – 28,74 | 0,556[b] |
| Mixed race | 119 | (67,2) | 40 | (22,6) | 2,23 | 0,48 – 10,40 | |
| Black | 4 | (2,3) | 3 | (1,7) | 1 | | |

Legend [a)] Chi-square test; [b)] Fisher's exact test. OR = crude odds ratio; 95% CI = 95% confidence interval.
**Source:** Research data.

The clinical characteristics were also analyzed based on the patients' outcomes, comorbidities, and length of hospital stay, as described in Table 2. The presence or absence of comorbidities did not show statistical significance. The presence of isolated or combined systemic arterial hypertension (SAH) and diabetes mellitus (DM) also did not yield statistically significant results, and the occurrence of other diseases was not significant for the death outcome. Additionally, there was no statistically significant association between the length of hospital stay and the clinical outcome (p=0.158).

**Table 2** – Clinical outcome according to the clinical characteristics of patients receiving treatment in the intensive care unit for SARS-CoV-2 infection.

| Variables | Outcome | | | | OR | 95% CI | p-value |
|---|---|---|---|---|---|---|---|
| | Death | | Discharge | | | | |
| | n | % | n | % | | | |
| **Comorbidities** | | | | | | | |
| No | 25 | (13,8) | 13 | (7,2) | 1 | | 0,227[a] |
| Yes | 108 | (59,7) | 35 | (19,3) | 1,60 | 0,74 – 3,47 | |
| **Hypertension only** | | | | | | | |
| No | 99 | (54,7) | 38 | (21,0) | 1 | | 0,512[a] |
| Yes | 34 | (18,8) | 10 | (5,5) | 1,30 | 0,59 - 2,90 | |
| **Diabetes Mellitus only** | | | | | | | |
| No | 123 | (68,0) | 46 | (25,4) | 1 | | 0,521[b] |
| Yes | 10 | (5,5) | 2 | (1,1) | 1,87 | 0,39 - 8,86 | |
| **Hypertension and/or Diabetes Mellitus + Other** | | | | | | | |
| No | 77 | (42,5) | 27 | (14,9) | 1 | | 0,843[a] |
| Yes | 56 | (30,9) | 21 | (11,6) | 0,94 | 0,48 – 1,82 | |
| **Other diseases Only** | | | | | | | |
| No | 125 | (69,1) | 46 | (25,4) | 1 | | 0,734[b] |
| Yes | 8 | (4,4) | 2 | (1,1) | 1,47 | 0,30 - 7,19 | |
| **Length of hospital stay** | | | | | | | |
| 1 to 9 days | 79 | (41,1) | 32 | (16,7) | 1,23 | 0,11 - 14,1 | 0,158[b] |
| 10 to 19 days | 52 | (27,1) | 16 | (8,3) | 1,63 | 0,14 - 19,1 | |
| 20 to 29 days | 10 | (5,2) | 0 | (0,0) | 8,1E+08 | 0,00 - | |
| 30 days or more | 2 | (1,0) | 1 | (0,5) | 1 | | |

Legend: [a] Chi-square test; [b] Fisher's exact test. OR = crude odds ratio; 95% CI = 95% confidence interval.
**Source:** Research data.

Table 3 presents the analysis of the discharge or death outcome in relation to the symptoms exhibited by the patients. Significant results were observed for patients with fever compared to those without fever. Those who experienced fever had a 3.8-fold higher likelihood of death from COVID-19 (OR=3.81, 95% CI 1.80-8.04, p<0.001). Participants who did not exhibit cough also displayed significant findings, as they had a 2.3-fold higher chance of death (OR=2.31, 95% CI 1.17-4.58, p=0.015). The absence of other symptoms, including asthenia, headache, chest pain, diarrhea, abdominal pain, myalgia, and anosmia, was also found to be significant for the death outcome. Patients who did not present these symptoms had a 2.9-fold higher chance of mortality (OR=2.87, 95% CI 1.47-5.59, p=0.002) compared to those who experienced these symptoms.

**Table 3** – Clinical outcome based on the symptoms of patients undergoing treatment in the intensive care unit for SARS-CoV-2 infection.

| Variables | Outcome | | | | OR | 95% CI | p-value |
|---|---|---|---|---|---|---|---|
| | Death | | Discharge | | | | |
| | n | % | n | % | | | |
| **Fever** | | | | | | | |
| No | 68 | (35,4) | 38 | (19,8) | 1 | | **<0,001[a]** |
| Yes | 75 | (39,1) | 11 | (5,7) | 3,81 | 1,80 - 8,04 | |
| **Cough** | | | | | | | |
| No | 108 | (56,3) | 28 | (14,6) | 2,31 | 1,17 - 4,58 | **0,015[a]** |
| Yes | 35 | (18,2) | 21 | (10,9) | 1 | | |
| **Dyspnea** | | | | | | | |
| No | 1 | (0,5) | 2 | (1,0) | 1 | | 0,161[b] |
| Yes | 142 | (74,0) | 47 | (24,5) | 6,04 | 0,54 - 68,16 | |
| **Other Symptoms** | | | | | | | |
| No | 95 | (49,5) | 20 | (10,4) | 2,87 | 1,47 - 5,59 | **0,002[a]** |
| Yes | 48 | (25,0) | 29 | (15,1) | 1 | | |

Legend: [a] Chi-square test; [b] Fisher's exact test. OR = crude odds ratio; 95% CI = 95% confidence interval.
**Source:** Research data.

The clinical outcome, related to the medication classes used during the hospitalization period, was examined through binary logistic regression. It was observed that patients who were administered sedatives, neuromuscular blockers (NMBs), and opioids had a higher likelihood of death from COVID-19. In this patient group (OR=4.47, 95% CI 2.25-8.88, p<0.001), the chances of death were 4.5 times greater. Patients who received vasoactive drugs (OR=20.14, 95% CI 4.71-86.11, p<0.001) also exhibited a significantly elevated risk of death. However, no significant findings were obtained for antimicrobial drugs and other medication classes due to incomplete data in some cells of the table. It should be noted that all patients received antimicrobials, and other medication classes were utilized by 99% of the sample (Table 4).

**Table 4** – Clinical outcome based on the medication classes used by patients undergoing treatment in the intensive care unit for SARS-CoV-2 infection.

| Variables | Outcome | | | | OR | 95% CI | p-value |
|---|---|---|---|---|---|---|---|
| | Death | | Discharge | | | | |
| | N | % | n | % | | | |
| **Antimicrobials** | | | | | | | |
| No | - | - | - | - | - | - | - |
| Yes | 143 | (74,5) | 49 | (25,5) | | | |
| **Anticoagulants** | | | | | | | |
| No | 16 | (8,3) | 1 | (0,5) | 6,04 | 0,78 – 46,85 | 0,077[b] |
| Yes | 127 | (66,1) | 48 | (25,0) | 1 | | |
| **Corticosteroids** | | | | | | | |
| No | 4 | (2,1) | 2 | (1,0) | 1 | | 0,646[b] |
| Yes | 139 | (72,4) | 47 | (24,5) | 1,48 | 0,26 - 8,33 | |
| **Sedatives_NMB_Opioids** | | | | | | | |
| No | 35 | (18,2) | 29 | (15,1) | 1 | | **<0,001[a]** |
| Yes | 108 | (56,3) | 20 | (10,4) | 4,47 | 2,25 - 8,88 | |
| **Vasoactive drugs** | | | | | | | |
| No | 77 | (40,1) | 47 | (24,5) | 1 | | **<0,001[a]** |
| Yes | 66 | (34,4) | 2 | (1,0) | 20,14 | 4,71 – 86,11 | |
| **Other medications** | | | | | | | |
| No | 1 | (0,5) | - | - | - | - | - |
| Yes | 142 | (74,0) | 49 | (25,5) | | | |

Legend: [a] Chi-square test; [b] Fisher's exact test. OR = crude odds ratio; 95% CI = 95% confidence interval.
**Source:** Research data.

The laboratory biomarkers of patients undergoing treatment for SARS-CoV-2 infection in the intensive care unit (Table 5) exhibited significant findings for three coagulation biomarkers. The mean values were higher for patients who experienced death compared to those who were discharged in terms of Prothrombin Time [PT] 2.36; (t (154.6) = 5.390; p=0.001); Activated Partial Thromboplastin Time [APTT] 2.24; (t (140.99) = 2.71; p=0.005), and D-dimer [DD] 3.27; (t (16.34) = 3.57; p=0.006). The effect size was medium for PT (Cohen's d = 0.70) and APTT (Cohen's d = 0.40), and large for DD (Cohen's d = 1.59).

Among the liver biomarkers, only Albumin [ALB] exhibited statistically significant results. The mean value for patients who were discharged was higher than that for patients who died, with a mean difference of -0.62 (t (61.53) = -4.54; p=0.001), and the effect size was large (Cohen's d = 1.09).

Regarding the evaluated renal biomarkers, significant results were observed, with higher mean values for patients who experienced death compared to those who were discharged. Urea [URE] had a mean difference of 78.97 (t (189.62) = 9.23; p=0.001), with a large effect size (Cohen's d = 1.01). Creatinine [CREA] exhibited a mean difference of 1.11 (t (119.21) = 4.16; p=0.001), and Potassium [K] had a mean difference of 0.67 (t (122.46) = 4.98; p=0.001), both with a medium effect size (Cohen's d = 0.58) (Cohen's d = 0.70).

Among the analyzed clinical and inflammation biomarkers, Hemoglobin [HB] demonstrated significance with higher mean values among patients who were discharged, exhibiting a mean difference of -0.91 (t (86.72) = -2.31; p=0.019). However, the effect size was small, indicating that although the result is statistically significant, the difference in means is not substantial (Cohen's d = 0.38). The

remaining biomarkers showed higher mean values for patients who died. Leukocytes [WBC] exhibited a mean difference of 6882.87 (t (189.74) = 5.74; p=0.001), with a medium effect size (Cohen's d = 0.63). C-reactive protein [CRP] demonstrated a mean difference of 45.16 (t (132.81) = 5.04; p=0.001), and its effect size was also medium (Cohen's d = 0.66). Finally, blood glucose [GLU] exhibited a mean difference of 42.58 (t (114.8) = 3.42; p=0.003), with a medium effect size (Cohen's d = 0.49).

**Table 5** – Clinical outcome according to laboratory tests of patients undergoing treatment in the intensive care unit for SARS-CoV-2 infection.

| Variables | Outcome | | | | *p*-value |
|---|---|---|---|---|---|
| | Death | | Discharge | | |
| | n | Mean ± SD | n | Mean ± SD | |
| CKMB (U/L) | 23 | 81,80 ± 127,02 | 04 | 48,25 ± 40,19 | 0,338 |
| CKMB (ng/ml) | 14 | 6,88 ± 9,17 | 08 | 4,75 ± 6,58 | 0,560 |
| MIO (ng/ml) | 16 | 199,7 ± 163,63 | 09 | 80,68 ± 130,08 | 0,063 |
| TROP (ng/ml) | 47 | 0,47 ± 1,75 | 11 | 0,14 ± 0,15 | 0,400 |
| LDH (U/L) | 126 | 1289,4 ± 1296,7 | 41 | 1429,5 ± 5376,9 | 0,772 |
| PLAQ (mm3) | 143 | 251129,4 ± 138187,8 | 49 | 264673,5 ± 94983,0 | 0,463 |
| PT (sec.) | 110 | 15,31 ± 3,91 | 47 | 12,95 ± 1,57 | **0,001** |
| APTT (sec.) | 101 | 27,44 ± 6,4 | 47 | 25,20 ± 3,6 | **0,005** |
| DD (ng/L) | 13 | 6,02 ± 2,37 | 07 | 2,75 ± 1,68 | **0,006** |
| ALT (U/L) | 133 | 133,33 ± 329,2 | 35 | 91,97 ± 113,7 | 0,289 |
| AST (U/L) | 133 | 154,0 ± 380,3 | 37 | 69,8 ± 51,9 | 0,121 |
| BIL (mg/dl) | 28 | 1,1 ± 1,3 | 04 | 0,63 ± 0,37 | 0,153 |
| ALB (g/dl) | 46 | 3,07 ± 0,57 | 31 | 3,69 ± 0,61 | **0,001** |
| URE (mg/dl) | 143 | 130,9 ± 89,55 | 49 | 51,9 ± 28,91 | **0,001** |
| CREA (mg/dl) | 140 | 2,45 ± 2,06 | 47 | 1,34 ± 1,38 | **0,001** |
| Na (mmol/L) | 140 | 193,15 ± 594,05 | 48 | 137,0 ± 5,66 | 0,431 |
| K (mmol/L) | 139 | 4,84 ± 1,05 | 48 | 4,16 ± 0,70 | **0,001** |
| HB (g/dl) | 142 | 12,09 ± 2,46 | 49 | 13,00 ± 2,36 | **0,019** |
| WBC (mm3) | 143 | 1295,66 ± 1957,84 | 49 | 1358,99 ± 796,87 | 0,774 |
| CRP (mg/dl) | 143 | 17631,33 ± 12535,3 | 49 | 10748,45 ± 4084,21 | **0,001** |
| GLU (mg/dl) | 137 | 87,66 ± 74,79 | 44 | 42,50 ± 41,73 | **0,001** |
| CKMB (U/L) | 140 | 215,4 ± 92,70 | 49 | 172,8 ± 67,61 | **0,003** |

Legend: p-value = Student's t-test (Bootstrapping sample). SD = Standard deviation.
**Source:** Research data.

## DISCUSSION

In this study, we identified key characteristics of COVID-19 progression and laboratory test results that hold prognostic value for mortality outcomes in adults hospitalized in the Intensive Care Unit with SARS-CoV-2 infection. The patient characteristics align with findings from studies conducted in other countries, demonstrating a higher prevalence of infected males. However, no significant association between gender and mortality risk was observed.[12]

Individuals aged 60 and above exhibited an elevated risk of mortality, while the presence of one or more pre-existing health conditions did not show a significant association. Patients presenting symptoms such as fever, disorientation, and tachycardia displayed a heightened likelihood of mortality. Similarly, as seen in other health conditions, COVID-19 patients requiring ICU care faced an increased risk of mortality. Consequently, establishing severity criteria for prognosis is essential to enable early intervention for these patients.[13-16]

Since SARS-CoV-2 is a recent discovery, an effective treatment has yet to be found. It was observed that patients administered sedatives,

neuromuscular blockers, opioids, and vasoactive drugs exhibited odds ratios of 4.47 and 20.[14] for mortality, respectively. The heightened mortality odds can be attributed to the fact that these patients received ICU care, and the use of these drug classes is necessary to provide support, such as mechanical ventilation, in cases of severe hypoxemia, aiming to prevent patient-ventilator asynchrony. This association may also contribute to an increased likelihood of mortality among hospitalized patients admitted to the ICU.[17]

Further studies are warranted to confirm the impact of medication classes on hospitalized individuals. Discussions on treatments involving antibiotics and glucocorticoids persist, with some studies indicating that these medications do not yield favorable prognoses when administered to individuals with COVID-19.[18] However, other studies have shown that corticosteroid use reduced mortality within 28 days among patients requiring invasive mechanical ventilation, and early administration of glucocorticoids and antibiotics may effectively attenuate the inflammatory cascade triggered by viral infections.[19-20,10]

Presently, nonspecific treatment and supportive care remain the primary options for alleviating the clinical symptoms of infected patients. This approach encompasses maintaining fluid and electrolyte balance, routine blood tests, and monitoring of biochemical markers, such as liver and cardiac enzymes, renal function, coagulation function, and ensuring timely oxygen delivery.[21]

Regarding laboratory biomarkers, during hospitalization, among patients in ICU beds who died compared to those who were discharged, an increase in coagulation activity was found, as evidenced by prolonged prothrombin time and activated partial thromboplastin time in the non-survivor group, along with elevated D-dimer concentrations, which are associated with coagulation disorders such as disseminated intravascular coagulation. These findings align with what other studies have reported, indicating that D-dimer levels greater than 1 µg/mL are associated with fatal outcomes in COVID-19 and serve as a significant independent predictor of severe pneumonia in COVID-19 patients, as coagulopathy and organ dysfunction have been linked to high mortality.[22-24]

In our analysis, we included biomarkers proposed by the Ministry of Health to cover a relevant portion of the pathophysiological mechanisms that potentially influence disease severity. Among these, the significance of decreased serum albumin concentration was observed in patients who progressed to mortality. Serum albumin levels are related to liver and renal functions, as well as nutritional status, which is often compromised during prolonged and complicated hospitalizations. Furthermore, decreased albumin levels were significantly associated with a higher likelihood of death.[5]

Other abnormal laboratory findings include increased C-reactive protein, which may reflect the hyperinflammatory state induced by SARS-CoV-2 infection, and elevated leukocyte count. Additionally, decreased platelet count and increased levels of urea and creatinine were observed in the group that progressed to mortality, indicating compromised renal function and corroborating other research that demonstrated significantly higher leukocyte counts in severely ill patients compared to non-severe cases or survivors versus non-survivors.[25-26] High levels of C-reactive protein have also been noted in some studies. Thus, dynamic monitoring of leukocytes, PCR, albumin, and other biomarkers may be significant in predicting the prognosis of critically ill patients, given that the fatal characteristic of COVID-19 is primarily attributed to severe systemic inflammation.[27-28]

The limitations of this study are related to the secondary nature of the data and the absence of certain information. Additionally, some laboratory tests, such as CK-MB and D-dimer, were not conducted for the majority of patients. These tests

are considered important in clinical evaluation during the management of critically ill patients and were included in the analysis; however, this may introduce biases in the analysis of these biomarkers.

## CONCLUSION

Our findings align with previous studies, indicating that patients aged 60 or above face a higher risk of mortality compared to those under 60 years old. The presence of symptoms such as fever increases the risk, while the absence of other symptoms like asthenia, headache, diarrhea, and cough is associated with a higher likelihood of mortality and the need for ICU admission. The use of sedatives and vasoactive drugs demonstrated statistical significance and exhibited higher odds ratios for mortality. Regarding the analyzed cardiac, hepatic, renal, clinical, and coagulation biomarkers, significant differences were observed only in Prothrombin Time, Activated Partial Thromboplastin Time, D-dimer, Albumin, Urea, Creatinine, Potassium, Leukocyte count, C-reactive protein, and Blood Glucose levels between deceased patients and those who were discharged. These biomarkers hold potential for evaluating and monitoring the clinical condition of patients undergoing treatment, providing initial insights into the characteristics of COVID-19 patients in the interior of Maranhão. It should be noted that these results pertain to the treatment administered during the first wave of the pandemic, and further studies are warranted to explore the relationship between these biomarkers and the medication classes employed in the intensive treatment of COVID-19 patients.


## RESUMO

**Introdução:** Analisar os biomarcadores laboratoriais de pacientes com infecção pelo SARS-CoV-2 em hospitais públicos no Maranhão, e comparar os resultados entre aqueles que tiveram alta e os que não sobreviveram. **Delineamento:** Trata-se de estudo de corte transversal, com amostra de 192 prontuários de pacientes internados no período de julho a dezembro de 2020, que avaliou sexo, faixa etária, raça, comorbidades, tempo de hospitalização, sintomas e classes de medicamentos, bem como biomarcadores clínicos, cardíacos, hepáticos, renais e de coagulação, analisados no *software* SPSS (20.0). **Resultados:** Verificou-se que o sexo masculino e a idade acima de 60 anos foram características dos participantes, e essa faixa etária foi significativa para risco de óbito. A presença de sintomas como febre (OR=3,81) e ausência de tosse (OR=2,31), bem como a utilização de sedativos (OR= 4,47) e de drogas vasoativas (OR=20,14) apresentaram maior chance para o desfecho de óbito. Na comparação de biomarcadores de pacientes hospitalizados em leito de UTI que tiveram alta com os que faleceram, destaca-se média maior para o tempo de protrombina, tempo de tromboplastina parcial ativada, D-dímero, ureia, creatinina, potássio, leucócitos, PCR e glicemia, assim como média diminuída de albumina entre os que faleceram. **Implicações:** Assim, esses biomarcadores podem contribuir para a avaliação da progressão da doença e monitoramento do estado de saúde dos pacientes tratados em leitos de UTI.



**DESCRITORES**

Biomarcadores; Coronavírus; Assistência Hospitalar; Saúde Pública.



## RESUMEN

**Introducción:** Este estudio tiene como objetivo analizar los biomarcadores de laboratorio en pacientes hospitalizados infectados con SARS-CoV-2 en hospitales públicos de Maranhão y comparar los resultados entre aquellos que fueron dados de alta y aquellos que no sobrevivieron. **Delineación**: Se llevó a cabo un estudio transversal que evaluó una muestra de 192 historias clínicas de pacientes ingresados entre julio y diciembre de 2020. Se evaluaron variables como sexo, grupo de edad, raza, comorbilidades, duración de la estancia hospitalaria, síntomas, clases de medicamentos y biomarcadores clínicos relacionados con las funciones cardíacas, hepáticas, renales y de coagulación. Los datos se analizaron utilizando el software SPSS (versión 20.0). Resultados: Los participantes fueron predominantemente hombres y mayores de 60 años, y este grupo de edad se asoció significativamente con un mayor riesgo de muerte. Se encontró una asociación significativa entre los síntomas como fiebre (OR=3,81) y la ausencia de tos (OR=2,31), así como el uso de sedantes (OR=4,47) y medicamentos vasoactivos (OR=20,14), y un mayor riesgo de mortalidad. Al comparar los biomarcadores de los pacientes hospitalizados en la unidad de cuidados intensivos (UCI) que fueron dados de alta en comparación con aquellos que fallecieron, se observaron valores medios más altos de tiempo de protrombina, tiempo de tromboplastina parcial activada, D-dímero, urea, creatinina, potasio, leucocitos, PCR y niveles de glucosa entre los pacientes fallecidos. Por otro lado, se observaron niveles medios más bajos de albúmina en aquellos que no sobrevivieron. Implicaciones: Por lo tanto, estos biomarcadores pueden contribuir a la evaluación de la progresión de la enfermedad y al monitoreo del estado de salud de los pacientes tratados en entornos de UCI.



**DESCRIPTORES**

Biomarcadores; Coronavírus; Atención Hospitalaria; Salud Pública.

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## COLLABORATIONS

DLS: contributed to the study conception, data collection, data interpretation, manuscript preparation, and approval of the final version. MESM: contributed to the study conception and design, evaluation of the stages, manuscript drafting, critical content review, and approval of the final version. The authors are responsible for all aspects of the work, ensuring its accuracy and integrity. **All authors agree and take responsibility for the content of this version of the manuscript to be published.**

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## AVAILABILITY OF DATA

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## CONFLICTS OF INTEREST

There are no conflicts of interest to declare.