Investigating Factors Impacting Hospitalization Duration in COVID-19 Patients: A Retrospective Case-Control Study in Jordan

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ABSTRACT

Objective: Coronavirus disease 2019 (COVID-19) is a severe acute respiratory illness of the upper respiratory tract. Evaluating the variables that influence the period of hospitalization and complications in COVID-19 patients can help effectively and safely decrease undesirable events. Therefore, the present study aimed to evaluate parameters influencing the length of hospital stay (LOS) in COVID-19 patients.

Patients and Methods: A retrospective case-control study involving hospitalized patients due to COVID-19. Demographic information, clinical treatment, and laboratory data were obtained from their medical records. Laboratory assessments included C-reactive protein (CRP), D-Dimer, lactate dehydrogenase (LDH), ferritin, urea, creatinine, estimated glomerular filtration rate (eGFR), uric acid, and complete blood count. Statistical analyses involved bivariate and multivariate logistic regressions to identify predictors of prolonged LOS.

Results: The median LOS for 83 patients was 7 days (IQR = 6–8). The median age of the patients was 58 years. Approximately half the patients were in the high-risk group (44.6%). The multivariate logistic regression analysis revealed that high neutrophil count (AOR = 1.144 95% CI 1.059–1.236, p = 0.001) increased the odds of prolonged LOS. In contrast, high creatinine levels decreased the odds of prolonged LOS (AOR 0.431, 95% CI 0.211–0.880, p = 0.021).

Conclusions: LOS was associated with increased neutrophil and decreased creatinine. Understanding these factors can assist in optimizing care and resource allocation in hospitals during health crises.

Keywords: COVID-19; Length of hospital stay; Jordan.

INTRODUCTION

Coronavirus disease 2019 (COVID-19) emerged in the Chinese city of Wuhan, and due to its high transmissibility has spread rapidly around the globe[1-3]. COVID-19's ongoing pandemic has caused significant risk to healthcare globally[4, 5].

Healthcare institutions throughout the globe are experiencing an extraordinary severe crisis due to their inadequate capability. Early management optimization may enhance the prognosis in individuals at high risk of acquiring the most severe manifestations, although initial detection of poor prognosis and risk classification is still a problematic issue[6]. As a result, accurate biomarkers or risk evaluation frameworks that can indicate a severe prognosis sooner are required to assist physicians in making decisions about the most suitable treatment strategy to achieve appropriate healthcare for each individual[7].

COVID-19 pandemic has caused substantial socioeconomic implications worldwide[8]. As COVID-19 pandemic persists, governmental healthcare and commercial organizations, and individuals are examining various ways to deal with it[9]. Early diagnosis and

predictive modelling may improve the available therapeutic choices, leading to better clinical results and allowing limited resources to be used more effectively to combat COVID-19 and any future pandemic[10]. To mitigate the significant risk of mortality and optimize patient outcomes, it is imperative to develop therapeutic strategies that precisely predict both the risk of death and the length of hospital stay (LOS)[11]. Simultaneously, the exponential spread of infections necessitates an increase in working hours for healthcare workers (HCWs), which poses serious threats to their mental and physical health, underscoring the critical need for interventions that ensure their safety and well-being [12]. The aim of the current study is to evaluate risk factors associated with prolonged LOS of COVID-19 patients to enhance healthcare services and minimize economic and work burden.

METHODOLOGY:

Study sample

This is a retrospective case-control study that was conducted at Istiklal Hospital. Istiklal Hospital is one of the authorized institutions in Amman, Jordan, for the isolation and care for COVID-19 patients. 172 patients were hospitalized from January 13 until August 16, 2021, of which 89 patients were excluded due to either highly missing data or death. Ages of the enrolled participants were ranging from (1-93) years old. The severity of Covid-19 risk experienced by participants was estimated utilizing the Centers for Disease Control and Prevention (CDC) categorization (Centers for Disease Control and Prevention, 2021) [13].

Measurements

During their stay at Istiklal Hospital in Amman, Jordan, COVID-19 patients underwent a wide range of laboratory tests to check their health indicators. These tests included complete blood count (CBC), liver and kidney functions, electrolytes, lactate dehydrogenase (LDH) and C-reactive protein (CRP). To make sure the data was consistent and accurate, all tests were carried out with standardized equipment in the hospital's clinical lab. This careful setup ensured that the data gathered was reliable and helped meet the study's goals effectively.

Statistical Analysis

Continuous variables and categorical variables were described by medians (interquartile, IQR) and frequencies (percentages, %). Patients were grouped based on the sample median LOS (>7 and ≤7 days) to anticipate factors and variables that may impact LOS. For each predictor variable, bivariate binary logistic regressions were performed to calculate crude odds ratios (CODs). To correct for potential confounders and determine the unique association of each predictor with LOS, variables with a p-value of less than 0.25 in the bivariate binary logistic regressions (14 variables) were included in a forward stepwise multivariate binary logistic regression analysis. Adjusted odds ratios (AORs) were computed for each of the significant predictors in the multivariate binary logistic regression. Multicollinearity between different predictors was evaluated by applying chi-square and Pearson's correlations. Nagelkerke R Square was examined to determine the most suitable model that explains the most variance in the outcome variable, while minimizing the number of predictors to avoid model overfitting. All statistical analyses were conducted using IBM SPSS, version 22. Finally, a p-value of less than 0.05 was considered statistically significant.

RESULTS

A total of 83 patients were included in the final analysis. Males made up most of the research participants, 53(63.9 %). The median age of the research participants was 58 years (IQR = 44-73). **(Table1)**

Table1. Sociodemographic characteristics of diagnosed COVID-19 study population

Variables	Category	Frequency	%
Gender	Male	53	63.9
	Female	30	36.1
Male age (years)	Median (IQR)	58 (42.50-72)	
Female age (years)	Median (IQR)	58.50 (47.75-73)	
Age (years)	Median (IQR)	58 (44-73)	
Age group (years)			
	1-19	2	2.4
	20-39	11	13.3
	40-59	33	39.8
	≥60	37	44.6
LOS for males (days)	Median (IQR)	8 (5-10.50)	
LOS for females (days)	Median (IQR)	6 (4.75-11.25)	
LOS (days)	Median (IQR)	7 (5-11)	
Hospital LOS	<7 days	35	42.2
Hospital LOS	≥7 days	48	57.8
Current Smoking	YES	4	4.8
	NO	79	95.2

LOS: length of stay, IQR: interquartile range

Fever and cough were experienced by 54 (65.1%) and 70 (84.3%), patients respectively. Most patients (80.7%) had respiratory difficulties. In addition, as indicated in **(Table2)**, the median SpO2, respiratory rate, and body temperature at admission were 95 (IQR = 92–96), 19 (IQR = 18–20), and 36.90 (IQR = 36.60–37.30) respectively.

Table2. Clinical, risky behavioral characteristics of COVID-19 patients

Variables	Category	Frequency	%
Fever	YES	54	65.1
	NO	29	34.9
Cough	YES	70	84.3
	NO	13	15.7
Difficulty of breathing	YES	67	80.7
	NO	16	19.3
Symptoms prior to admission	Days	7 (3-10)	
Temperature (°C)	Median (IQR)	36.90 (36.60-37.30)	
Respiratory rate	Median (IQR)	19 (18-20)	
Heart rate	Median (IQR)	85 (77-96)	
Spo2	Median (IQR)	95 (92-96)	
MAP	Median (IQR)	95.33 (88.33-100.33)	
Presentation with comorbidities	YES	40	51.8
	NO	43	48.2
Degree of Covid-19 risk			
	High-Risk Group	37	44.6
	Medium-Risk Group	13	15.7
	Low-Risk Group	33	39.8
Covid-19 patients' laboratory findings			
CRP	Median (IQR)	70 (23.94-122)	
D-Dimer	Median (IQR)	0.57 (0.30-0.89)	
LDH	Median (IQR)	458 (379.90-542.20)	
Ferritin	Median (IQR)	697.50 (425-1309)	
Urea	Median (IQR)	48.20 (34.60-68.30)	
Creatinine	Median (IQR)	0.79 (0.65-1.02)	
eGFR	Median (IQR)	90.90 (57.90-126.70)	
Uric acid	Median (IQR)	4.70 (3.80-5.70)	

Variables	Category	Frequency	%
Hemoglobin	Median (IQR)	14.10 (12.40-14.90)	
Red blood cells count	Median (IQR)	5.04 (4.66-5.34)	
Platelets count	Median (IQR)	367 (275-441)	
White blood cells count	Median (IQR)	10.70 (7.63-14.54)	
Neutrophils count	Median (IQR)	88 (82.50-92)	
Lymphocytes count	Median (IQR)	12 (8.50-18)	
Monocytes count	Median (IQR)	6 (4.60-8)	

MAP: mean arterial blood pressure, LDH: lactate dehydrogenase, CRP: c-reactive protein,

SPO2: saturation of peripheral oxygen, IQR: interquartile range, eGFR: Estimates glomerular filtration rate

The median LOS in the hospital was 7 (IQR=6-8) days. Patients with an elevated neutrophil count and deceased creatinine level significantly correlated with a more extended LOS. A one-unit rise in the neutrophil count was associated with a 14.4% increase in the likelihood of a prolonged LOS (AOR = 1.144, 95% CI: 1.059-1.236). The odds of having a one-unit rise in creatinine decreased LOS by 56.9% (AOR = 0.431, 95% CI: 0.221-0.880). Nagelkerke R Square revealed that the model explained 33% of the variation in LOS, the model's sensitivity and specificity were 83.30 and 45.70%, respectively. **(Table3)**

Table3. Factors associated with prolonged hospital stay among COVID-19 patients

Variables	COR (95%CI)	P	AOR (95%CI)	p
Gender	2.045 (0.823-5.085)	0.124	-	
Admission CRP	1.005 (0.999-1.012)	0.124	-	
Symptoms-PTA	1.067 (0.965-1.181)	0.206	-	
Heart rate	1.022 (0.988-1.056)	0.210	-	
Respiratory rate	0.925 (0.812-1.053)	0.237	-	
Admission SPO2	0.880 (0.761-1.019)	0.087	-	
General Weakness	2.035 (0.840-4.930)	0.115	-	
Chest Pain	2.025 (0.759-5.405)	0.159	-	
Vitamins	2.343 (0.791-6.943)	0.125	-	
LDH	1.002 (1.000-1.004)	0.132	-	
Creatinine	0.695 (0.390-1.241)	0.219	0.431 (0.210-0.880)	0.021
Platelets	1.003 (1.000-1.007)	0.079	-	
Neutrophils	1.111 (1.038-1.190)	0.002	1.144 (1.059-1.236)	0.001
Monocytes	0.858 (0.738-0.999)	0.049	-	

Omnibus x^2 (2) =23.368, p < 0.001, R^2 = 0.33 (Negelkerke), LDH: lactate dehydrogenase, CRP: c-reactive protein, PTA: prior to admission, SPO2: saturation of peripheral oxygen

DISCUSSION

Many nations' medical resources were depleted during the COVID-19 pandemic. Understanding hospital LOS and variables that influence it may help physicians make better decisions regarding patient selection, design solutions to limit LOS, and ultimately reduce resource consumption. This retrospective case-control study, characteristics and variables linked to LOS during hospitalization in patients with COVID-19 we evaluated.

Comparative Analysis of LOS

Patients in this study varied in age from 1 to 93 years old, with males accounting for more than half (63.9%) of the patients. Similar to research conducted in Beijing and other parts of China[14], COVID-19 might affect people of all ages from both genders. The LOS in our patients was 7 days (IQR = 6–8); in agreement with previous studies conducted in the United States and other European nations, in which the LOS was 7–8 days[15]. However, a research in Sichuan province, China, showed a broader range of in-hospital stay of 19 (IQR: 3–41) days. This disparity might be explained by differences in COVID-19 severity and/or management strategies.[16, 17].

Key Variables Affecting LOS

Bivariate binary logistic regression revealed that neutrophil count showed a higher prevalence of prolonged LOS among COVID-19 patients, it also revealed that no significant relationship between LOS and other characteristics previously linked to LOS or severe COVID-19 prognosis, such as age, gender, symptoms, and comorbidities were found in the present study[18-22]. However, because of differences in data collection methods (e.g., interviews vs. medical records), disease severity assessments used as outcomes (e.g., hospitalization, ICU admission, mechanical ventilation, or death), and how underlying medical conditions are distributed among various populations, some variation between the findings of this study and previous studies investigating risk factors for prolonged LOS are expected[23].

The results of the present study revealed that increased levels of inflammation-related variables, such as neutrophil, was shown to be associated with poor outcomes. Chemokines and cytokines are mostly produced by neutrophils. It has been found that elevated neutrophilia levels were prevalent in both the peripheral blood and lungs of SARS and MERS patients. These findings show that elevated neutrophils may be a prevalent feature of coronavirus infection. The monitoring of neutrophils count should be increased during hospitalization since numerous infections are usually associated with this disease and may result in a poor outcome[24]. Furthermore, clinical research should be more cautious and extensive, taking into consideration the patients' usage of corticosteroids due to their contradictory effects on neutrophilia.

In the other hand, an increase in creatinine level was linked to a lower prevalence of prolonged LOS. Low baseline blood creatinine levels were associated with an elevated mortality risk in a large retrospective cohort study of 11291 critically ill patients admitted to intensive care units. As a result, decreased serum creatinine levels may be associated with a prolonged LOS among COVID-19 patients [25]. A larger sample size of people from diverse backgrounds in Jordan and throughout the world might help us better understand what patient features, drugs, and underlying medical illnesses are connected to hospitalization and poor outcomes in individuals with COVID-19.

Implications for Healthcare Strategies

This study explored evidence for anticipating inpatient bed needs in an innovative public health intervention setting by investigating the duration of hospitalization, an important but underestimated parameter, and its related characteristics among COVID-19 patients hospitalized in Istiklal hospital. The association between neutrophil counts and prolonged LOS, emphasize the importance of monitoring neutrophils count in addition to other inflammatory biomarkers. Understanding these factors better helps us optimize patients care and may help decision-makers with strategies for increasing the performance of the healthcare system and allocating resources.

Limitations of the Study

This study has numerous limitations as follows: First, because of the change of testing procedures and demographics of infected people throughout the pandemic and participants' socioeconomic background and underlying health state, our results are particular to this population and may not be generalizable to other populations. Second, since

this is single-centered research with small sample size, our interpretation of the analytic findings may be limited. Therefore, future multicentral research with larger sample size can confirm the generalizability of the study results. Third, not all laboratory values for all patients were obtained due to the retrospective research structure. Missing data were replaced with the corresponding median value. Prospective studies with more rigorous data collection protocols are needed to minimize data gaps and improve the accuracy of the findings. Furthermore, reporting mistakes are likely to be non-discriminatory among research respondents. Finally, since a limited proportion of respondents reported numerous demographics or social factors, particular underlying medical problems, and treatments, our ability to draw inferences regarding their relationships with hospitalization was restricted; this also made it impossible to thoroughly investigate and compensate for the relationship of potential risk concerns. Future studies should prioritize comprehensive data collection methodologies, including standardized reporting guidelines, to ensure thorough documentation of demographics, social factors, medical history, and treatments, thereby facilitating more robust analyses and mitigating potential biases in assessing their relationships with hospitalization.

CONCLUSION

Identifying patients at high risk of developing poor clinical outcomes is a top concern for healthcare providers amidst the COVID-19 crisis. The study found that elevated neutrophil count was possible predictor of longer LOS. Patients with extended hospital stays typically require more intensive and prolonged medical interventions. Such scenarios necessitate increased use of pharmacological treatments, more frequent diagnostic testing, and greater utilization of non-pharmacological support measures (e.g., oxygen therapy, nutritional support). Consequently, these patients are expected to consume more pharmacological and non-pharmacological supplies while receiving medical treatment.

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فهم العوامل المؤثرة على مدة الإقامة في المستشفى بين مرضى كوفيد-19: دراسة استعادية للحالات والشواهد في الأردن

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ملخص

الهدف: مرض فيروس كورونا 2019 (كوفيد-19) هو مرض تنفسي حاد شديد مرتبط بعدوى الجهاز التنفسي العلوي) فيروس كورونا المستجد (SARS-CoV-2.). إن تقييم العوامل التي تؤثر على مدة الإقامة في المستشفى والمضاعفات لدى مرضى كوفيد-19 يمكن أن يساعد في تقليل الأحداث غير المرغوب فيها بشكل فعال وآمن. ولذلك، هدفت هذه الدراسة إلى تقييم العوامل التي تؤثر على مدة الإقامة في المستشفى لدى مرضى كوفيد-19.

المرضى والطرق: دراسة استعادية حالة-شاهد تشمل المرضى في عمان، الأردن، الذين تم تأكيد إصابتهم بفيروس كوفيد-19 مختبريًا وتم إدخالهم إلى المستشفى بين 13 يناير و16 أغسطس 2021. تم الحصول على المعلومات الديموغرافية، والعلاج السريري، وبيانات المختبر من سجلاتهم الطبية.

النتائج: كانت مدة الإقامة في المستشفى لـ 83 مريضًا المتوسطة 7 أيام (الفترة بين الربيع 6-8 أيام). للتحقيق في المتغيرات المترابطة مع مدة الإقامة الطويلة، تم استخدام الانحدار اللوجستي الثنائي المتغير والمتعدد المتغيرات. تم حساب نسب الأرجحية المعدلة (AORs) وفترات الثقة 95. (CIs) %كان متوسط عمر المرضى 58 سنة. وكان حوالي نصف المرضى في المجموعة عالية المخاطر (44.6%). وفقًا لتحليل الانحدار اللوجستي الثنائي المتعدد المتغيرات على الـ 83 مريضًا، تم العثور على أن أحد العوامل التي تعتبر عامل خطر لزيادة مدة الإقامة الطويلة هو عدد العدلات AOR) 1.144 = ، 95%1.236–1.059 CI ، .(0.001 = p. في المقابل، تم العثور على أن زيادة مستوى الكرياتينين يعتبر عامل وقاية ضد زيادة مدة الإقامة الطويلة(0.431 = AOR ، 95%0.880–0.211 CI ، .(0.021 = p.

الاستنتاجات: كانت احتمالية الإقامة لفترة طويلة في المستشفى مرتبطة بزيادة عدد العدلات، في حين أن زيادة وحدة واحدة في مستوى الكرياتينين كانت مرتبطة بتقليص مدة الإقامة في المستشفى.

الكلمات الدالة: كوفيد-19، مدة الإقامة في المستشفى، الأردن