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Assessment of Electrolyte Disturbances in Hospitalized Patients with COVID-19

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ABSTRACT

Background: Electrolyte abnormalities are commonly observed among patients admitted for coronavirus disease 2019 (COVID-19). These electrolyte imbalances may affect the severity of COVID-19 infection in patients.

Objective: To evaluate the prevalence of electrolyte imbalances among COVID-19 patients admitted in various hospitals and their possible clinical consequences.

Methodology: An observational cross-sectional study was carried out among 130 adult patients admitted with confirmed COVID-19 infection in a tertiary care hospital in Peshawar, Pakistan. Serum levels of sodium, potassium, calcium, and chloride were estimated on admission. The abnormalities of these electrolytes were determined based on standard reference ranges. Data was collected, and patterns of electrolyte abnormalities were observed.

Results: The electrolyte abnormalities were found in 64.7% of patients. The electrolyte abnormalities were found to be hyponatremia in 34.6%, followed by hypocalcemia in 29.2%, and hypokalemia in 25.3%. The electrolyte abnormalities were less frequently observed in the form of hypernatremia and hyperkalemia in 5.3% and 7.6%, respectively. The electrolyte abnormalities were associated with comorbid conditions such as hypertension and diabetes mellitus.

Conclusion: Electrolyte abnormalities like hyponatremia, hypocalcemia, and hypokalemia are commonly observed among hospitalized COVID-19 patients. These electrolyte imbalances are linked with increased severity and worsening outcomes among COVID-19 patients. Therefore, early recognition and management of these electrolyte imbalances are essential for improving the care and prognosis of COVID-19 patients.

Keywords: COVID-19; Electrolyte Disturbances; Hyponatremia; Hospitalized Patients; Disease Severity

Introduction

Coronavirus disease 2019, also known as COVID-19, caused by the severe acute respiratory syndrome coronavirus-2, was first reported at the end of 2019, but it soon spread to become a global health emergency.^{1,2} The disease manifests as a variety of symptoms, primarily affecting the respiratory system, which ranges from upper respiratory tract infections to pneumonia, acute respiratory distress syndrome, and even failure of multiple organs. Although the disease manifests as a variety of symptoms primarily affecting the respiratory system, a variety of reports suggest that the disease affects various systems, including the cardiovascular, renal, gastrointestinal, and endocrine systems, which might result in a variety of biochemical abnormalities, including electrolyte imbalance.²

Electrolytes like sodium, potassium, calcium, magnesium, and chloride are essential for maintaining homeostasis in the body. These electrolytes are critical for proper cell functions, nerve functions, muscle functions, acid-base balance, and fluid balance in the body. Any slight disturbances in the balance of these electrolytes can have a significant impact on the health of patients, especially those in the hospital and in critical care units.³ These disturbances can occur in the form of hyponatremia, hypernatremia, hypokalemia, hyperkalemia, hypocalcemia, and hypomagnesemia, and they can cause complications like cardiac, neurological, and respiratory problems.

Several mechanisms have been proposed that explain the occurrence of electrolyte disorders in patients with COVID-19.⁴ One such mechanism is the interaction between the SARS-CoV-2 virus and the angiotensin-converting enzyme 2 receptor, which is found in the lungs, kidneys, gastrointestinal system, and many other tissues in the body. The virus binds to the ACE2 receptor to gain access to the host cells, which disrupts the balance of the renin-angiotensin-aldosterone system (RAAS).⁵ This disruption may cause electrolyte disorders due to the effects on sodium and potassium balance. In addition, systemic inflammatory responses, renal failure, and gastrointestinal manifestations such as diarrhea and vomiting also cause electrolyte disorders in patients with COVID-19.

Another significant factor that plays a role in the electrolyte imbalance among COVID-19 patients admitted to hospitals is related to the effects of medical interventions and supportive care for the patients with moderate to severe COVID-19. In addition, it has been observed that patients with moderate to severe COVID-19 admitted to hospitals often develop various complications, including acute kidney injury, sepsis, and metabolic acidosis, which can cause disturbances in electrolyte balance.⁶

Several studies have documented that abnormalities in

the levels of electrolytes are very common in patients admitted to the hospital with COVID-19 infection. Among the abnormalities in the levels of electrolytes, hyponatremia and hypokalemia have been the two most commonly observed abnormalities.⁷ Hypocalcemia has been very commonly observed in patients with COVID-19 infection. Hypocalcemia may be related to the inflammatory response and vitamin D deficiency.⁸ In addition to the severity of the infection caused by the COVID-19 virus, the abnormalities in the levels of electrolytes may be used as prognostic factors for the outcome of the infection.

Therefore, early detection and proper management of electrolyte disturbances are critical in the care of hospitalized COVID-19 patients. The monitoring of electrolyte disturbances can help healthcare workers in the early detection of complications and prevent adverse outcomes in COVID-19 patients. In resource-limited healthcare settings, such as in many of the existing and functional hospitals in developing countries, it is critical to understand the pattern and prevalence of electrolyte disturbances in COVID-19 patients for proper management of the disease and its associated complications.

Despite the increasing literature on COVID-19, there is limited data on the incidence and pattern of electrolyte disturbances in COVID-19 patients admitted to hospitals in many parts of the world, including Pakistan. Regional studies are essential as they can affect the incidence of electrolyte disturbances in COVID-19 patients. Therefore, the present study was conducted to identify the pattern and frequency of electrolyte disorders in hospitalized COVID-19 patients, and this may assist in the early identification of complications, thereby improving patient outcomes in this newly emerging infectious disease.

Objective

To evaluate the prevalence of electrolyte imbalances among COVID-19 patients admitted in various hospitals and their possible clinical consequences.

Methodology

The current study is an observational cross-sectional study, which was carried out on patients admitted with confirmed infection of coronavirus disease (COVID-19) in a tertiary care hospital in Peshawar. The study was conducted within a specified period from January 2021 to December 2022. In this study a total of 130 patients were included using a convenient sampling method. Adult patients aged 18 years and above, diagnosed with COVID-19 using RT-PCR from nasopharyngeal swab samples, and with complete clinical and laboratory records, who were admitted for hospital management, were included in the study. Patients with a known history of chronic kidney diseases, endocrine disorders causing

electrolyte imbalance, or those on electrolyte supplementation before hospitalization were excluded from the study. In addition, patients with incomplete medical records were also not included in the study.

The data was collected using a structured data collection form developed for the purpose of this study. Demographic details such as the age and gender of the participants were recorded. Clinical details such as the symptoms presented by the patients, co-morbid diseases such as hypertension and diabetes mellitus, and the duration of hospitalization were collected.

Blood samples from the patients were collected at the time of hospital admission in the normal aseptic manner. Serum levels of various electrolytes like sodium, potassium, calcium, and chloride were measured by automated biochemical analyzers in the hospital lab. These results were interpreted based on the reference values. Hyponatremia was defined as a serum sodium level below 135 mmol/L. Hypernatremia was defined as a serum sodium level above 145 mmol/L. Hypokalemia was

defined as a serum potassium level below 3.5 mmol/L. Hyperkalemia was defined as a serum potassium level above 5.0 mmol/L. Hypocalcemia was defined as a serum calcium level below 8.5 mg/dL. The presence and type of electrolyte disturbances were recorded for each patient.

The statistical analysis was performed using SPSS software version 23.0. Ethical clearance for conducting this research was obtained from the institutional ethical review Board of Rehman Medical Institute before initiating the study. Confidentiality of patient information was strictly maintained during the research process, and all information was used for academic and research purposes only.

Results

The majority of patients were in the age group of 41–60 years (46.1%), followed by 18–40 years (36.1%), and 17.6% were above 60 years of age. There was a slight preponderance of males over females; 57.6% of patients

Table 1. Demographic and Clinical Characteristics of Hospitalized COVID-19 Patients

Variable	Category	Frequency (n)	Percentage (%)
Age Group (years)	18–40	47	36.1%
	41–60	60	46.1%
	>60	23	17.6%
Gender	Male	75	57.6%
	Female	55	42.3%
Comorbidities	Hypertension	33	25.3%
Common Symptoms	Diabetes Mellitus	25	19.2%
	Both HTN & DM	42	32.3%
	None	30	23.0%
	Fever	113	86.9%
	Cough	103	79.2%
	Shortness of Breath	88	67.6%
	Fatigue	64	49.2%
	Diarrhea	26	20.0%
Mean Hospital Stay	8.5 ± 3.3 days	-	-

Table 2. Pattern of Electrolyte Disturbances in Hospitalized COVID-19 Patients

Electrolyte Disturbance	Frequency (n)	Percentage (%)	Mean Level \pm SD
Hyponatremia (<135 mmol/L)	45	34.6%	131.8 \pm 3.4
Hypernatremia (>145 mmol/L)	7	5.3%	147.2 \pm 2.6
Hypokalemia (<3.5 mmol/L)	33	25.3%	3.1 \pm 0.3
Hyperkalemia (>5.0 mmol/L)	10	7.6%	5.6 \pm 0.4
Hypocalcemia (<8.5 mg/dL)	38	29.2%	7.9 \pm 0.5
Normal Electrolyte Levels	46	35.3%	—

were males and 42.3% were females. Regarding comorbid conditions, 32.3% of patients had concomitant hypertension and diabetes mellitus; 25.3% had only hypertension, and 19.2% had only diabetes mellitus. Fever (86.9%) and cough (79.2%) were the most frequent symptoms of illness, followed by shortness of breath (67.6%). The mean period of hospitalization was 8.5 ± 3.3 days for all patients (Table 1).

The most common electrolyte imbalance that occurred in this patient population was hyponatremia, which occurred in 45 (34.6%) of the patients. Next in order of frequency were hypocalcemia, which occurred in 38 (29.2%), and hypokalemia, which occurred in 33 (25.3%) of the patients. Other electrolytes that showed imbalance in this patient population were hyperkalemia and hypernatremia, which occurred in 7.6% and 5.3%, respectively. The average serum concentrations of sodium, potassium, and calcium were 131.8 ± 3.4 mmol/L, 3.1 ± 0.3 mmol/L, and 7.9 ± 0.5 mg/dL, respectively. In all, 46 patients (35.3%) had normal electrolyte concentrations. This showed that electrolyte imbalance is common among the majority of patients with COVID-19 who were hospitalized (Table 2).

Figure 1 shows the distribution of the electrolyte imbalance among hospitalized patients infected with COVID-19. Hyponatremia was the most prevalent electrolyte imbalance, followed by hypocalcemia and hypokalemia, while hyperkalemia and hypernatremia were relatively less prevalent. A significant number of patients were also found to be within the normal range, yet electrolyte imbalance was prevalent.

Discussion

The aim of this study is to assess the pattern and degree of electrolyte abnormalities in COVID-19 patients admitted to a tertiary care hospital in Peshawar. The findings of this study showed that electrolyte imbalance is one of the clinical abnormalities observed in patients with

COVID-19 infection admitted to hospitals. The electrolyte imbalances observed in this study were hyponatremia, hypocalcemia, and hypokalemia. The findings of this study showed the importance of monitoring electrolytes in patients with COVID-19 infection in order to avoid complications.

In the current study, it was observed that most of the patients were in the age group of 41-60 years. There was a slight preponderance of males in the current study population. This is in accordance with the findings of various previous studies related to COVID-19. In a study done by Liu (2020), it was observed that elderly patients were more likely to suffer from severe disease and have a poor prognosis compared to younger patients.⁹ In another study done by Qin et al., (2020), it was observed that there were differences in terms of gender between patients with COVID-19. It was observed that male patients had higher mortality and inflammatory responses compared to female patients. In male patients with COVID-19, it was observed that inflammatory markers were higher and lymphocyte levels were lower compared to female patients.¹⁰

In the patients who were the subject of the current study, the presence of hypertension and diabetes mellitus as comorbidities is a common phenomenon. Similar results were reported in previous studies. Fang (2020) reported that hypertension, diabetes mellitus, and cardiovascular diseases are the most common co-morbid conditions found in patients who were infected with COVID-19.¹¹ Similarly, another study done by Yanai (2020) reported that diabetes mellitus and hypertension are the most common co-morbid conditions found in patients infected with COVID-19. Patients with co-morbid conditions of diabetes mellitus and hypertension are at a greater risk of severe disease and death.¹² However, another study done by Parveen (2020) reported that patients with co-morbid conditions of diabetes mellitus and hypertension are associated with severe disease.¹³

In the current research, it has been found that

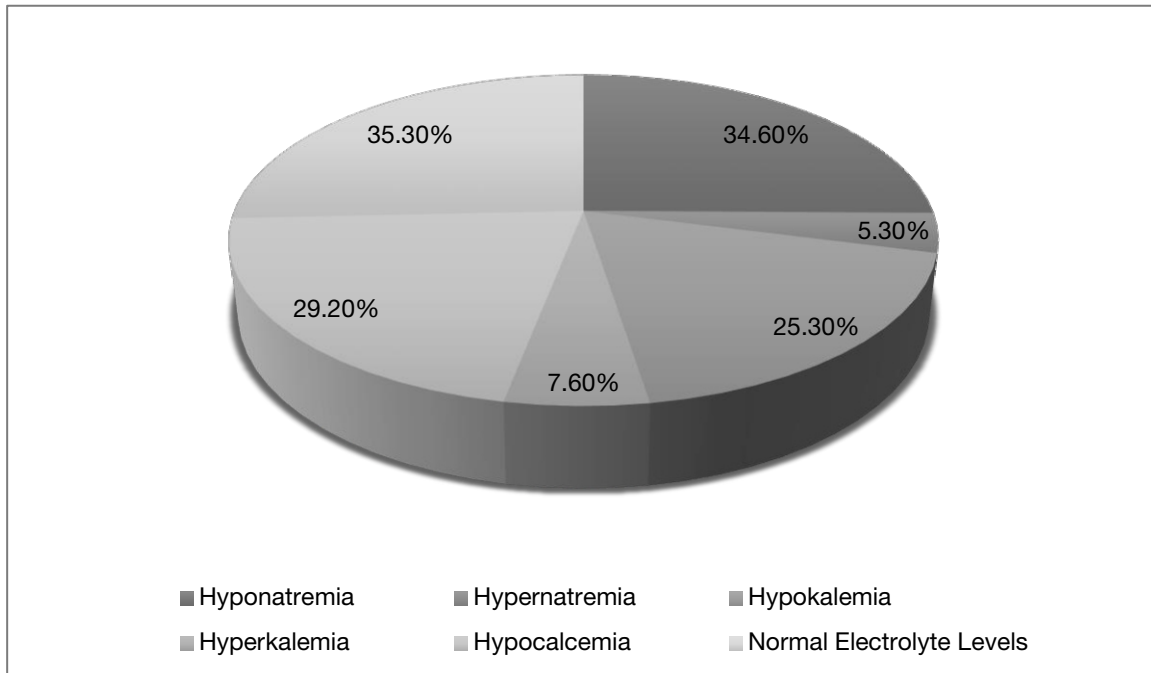


Figure 1. Frequency of Electrolyte Disturbances Among COVID-19 Patients

hyponatremia is the most prevalent electrolyte imbalance among hospitalized patients with COVID-19. Several previous studies have found the same results. A research conducted by Berni et al. (2021), found that hyponatremia is a commonly observed electrolyte imbalance in patients with COVID-19. The research has also found that the severity of the infection is greater in patients with hyponatremia. The hospitalization time is also greater in patients with hyponatremia.¹⁴ In another research conducted on patients with COVID-19 infection by Berni (2020), it has been found that the patients with a greater level of IL-6 had lower levels of sodium. The patients with lower sodium levels had lower oxygenation levels (PaO₂/FiO₂), indicating that the severity of the infection is greater.¹⁵ Several mechanisms can explain the development of hyponatremia in COVID-19 patients, which include the syndrome of inappropriate antidiuretic hormone secretion, systemic inflammation, pulmonary infections, and renal involvement.

Another electrolyte imbalance frequently observed in this study was hypokalemia. This was also observed in a study by Chen et al., (2020), who found that hypokalemia was a common electrolyte imbalance in COVID-19 patients and was more common in patients with more severe disease, resulting mainly from urinary potassium loss as a result of ACE2 degradation. The pathophysiology of hypokalemia in COVID-19 patients is thought to result from the interaction of the SARS-CoV-2 virus with the angiotensin-converting enzyme 2 receptor, leading to disruption of the renin-angiotensin-aldosterone system

with a resulting loss of potassium in the urine.¹⁶ Hypocalcemia was also commonly observed among the patients in the present study. Previous studies have also shown that hypocalcemia is commonly observed among patients with COVID-19 infection. A study done by Qi et al., (2021) showed that patients with severe COVID-19 had low calcium levels, blood clot problems, and increased inflammation. Low calcium was related to poor blood clotting and increased inflammation.¹⁷ Another study done by Sun et al., (2019) showed that most COVID-19 patients had low calcium levels. Low calcium was related to severe illness, organ damage, septic shock, and 28-day death rates.¹⁸ Similarly, a study done by Liu et al., (2020) found that hypocalcemia was common among severe COVID-19 cases. The condition was associated with increased inflammation, reduced lymphocytes and albumin levels, and increased risk of poor outcomes. Hypocalcemia was found to be a possible predictor of the outcome with moderate accuracy. The causes of hypocalcemia among COVID-19 patients include the systemic inflammatory response syndrome, vitamin D deficiency, altered response to parathyroid hormone, and changes in calcium metabolism during severe infections.¹⁹

Though not common, hyperkalemia and hypertatremia were also found among a small percentage of patients. These electrolyte disorders can be caused by renal disorders, dehydration, metabolic disorders, or associated with severe infections. Previous studies have suggested that electrolyte disorders such as hypertatremia may develop among patients during

hospitalization. This may be caused by fluid imbalance, the effects of drugs, or renal disorders.

The findings of the current study are similar to the findings of other international studies. Lippi (2020) found that electrolyte disorders, such as sodium and potassium disorders, are common among COVID-19 patients. These disorders may be considered potential prognostic indicators of the severity of the infection.²⁰ According to the study done by Tezcan (2020), more than half of the COVID-19 patients hospitalized experienced electrolyte disorders, such as hyponatremia. These disorders were associated with the severity of the infection and the mortality rate. Electrolyte disorders were associated with the hospitalization period.²¹

In the current research, a substantial number of patients were found with at least one abnormality in electrolyte levels, which highlights the fact that electrolyte imbalance is a common finding in hospitalized COVID-19 patients. This stresses the point that electrolyte levels should always be monitored during the hospital stay of the patient. This can prevent the patient from experiencing problems related to arrhythmias, neurological problems, etc.

Conclusion

Electrolyte imbalance is a highly prevalent complication in hospitalized COVID-19 patients, with hyponatremia, hypocalcemia, and hypokalemia being the most common electrolyte imbalances. The electrolyte imbalance is related to the severity of the disease, length of hospital stays, and prognosis of the disease. Electrolyte imbalance should be monitored and managed properly to improve the prognosis of hospitalized COVID-19 patients.

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