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An Observational Study on the Management of COVID-19 Patients in Limited-Resource Hospitals

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Abstract: *Background:* The purpose of this study was to evaluate the effectiveness of limited-resource hospitals in managing mild and moderate hospitalized cases of COVID-19 with comorbidities and in preventing their progression to severe illness. *Methods:* Data were obtained from 88 moderate COVID-19 patients with comorbidities who were admitted to limited-resource hospitals. The data were classified into several parts: comorbidities, chronic medication before hospital admission, symptoms of COVID-19 before and during hospitalization, clinical features, laboratory findings on hospital admission, complications during hospitalization, as well as worst laboratory values during hospitalization, hospital stay, and outcomes. The clinical features, laboratory results, type of oxygen therapy used, and the final treatment outcome were all evaluated to assess for any potential relationship. *Results:* All patients were alive upon discharge. Before admission, the majority of patients (60.2%) received COVID-19 treatment, and the average hospital stay was 12 days. The most common symptoms were fever (88.7%), cough (95.5%), shortness of breath (90.9%), myalgia (84.1%), confusion (63.6%), headache (62.5%), sore throat (88.7%), rhinorrhea (17%), chest pain (58%), diarrhea (19.3%), nausea and vomiting (38.6%), anosmia (62.5%), as well as dysgeusia (64.8%). Based on chest radiograph or computed tomography (CT) scan, 9.1% of the patients had unilateral pneumonia, 90.9% had bilateral pneumonia, and 96.6% had multiple mottling and ground-glass opacity. Age was found associated with a significant increase in headache ($p = 0.005$), rhinorrhea ($p = 0.013$), chest pain ($p = 0.007$), and the need for positive airway pressure ($p = 0.008$). Between pre- and post-hospital admissions, there was a significant increase in lactate dehydrogenase and ferritin but a decrease in platelet, D-dimer, hemoglobin, lymphocytes, neutrophils, and total leucocyte count ($p < 0.001$). There was a significant association between hospital stay and D-dimer level ($p = 0.05$). *Conclusion:* Limited-resource hospitals in Egypt were efficient in managing mild and moderate hospitalized cases of COVID-19 with

comorbidities. Many of these cases did not escalate to severe illness and were all alive upon discharge. Early management of COVID-19 tends to delay the disease progression to severe illness and improves patients' chances of survival. Treating COVID-19 or using oxygen therapy at home can also delay the need for hospitalization in mild or moderate cases.

Keywords: COVID-19; Limited-resource hospitals; COVID-19 laboratory tests; Comorbidities

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1. Background

The emergence of COVID-19 has exposed a critical shortage in supplies all around the world. The shortages include reagents for laboratory testing, hospital beds, hospital staffs, intensive care units, and invasive mechanical ventilators [1].

COVID-19 has affected the people all over the world, with varying degrees of severity. The severity and mortality of COVID-19 are higher among the elderly [2,3]. Those who are malnourished and have comorbidities, such as diabetes, hypertension, and tuberculosis, face a higher risk of developing severe COVID-19 illness [4,5].

Most ministries of health around the world have chosen limited-resource hospitals with insufficient supplies and intensive care units (ICUs) for the isolation of mild and moderate COVID-19 cases with comorbidities or those developing typical respiratory symptoms upon home isolation to prevent their progression to severe illness as the risk is higher for those with comorbidities to be isolated at home [6].

Hence, the purpose of this study was to evaluate the effectiveness of these hospitals in the management of mild and moderate hospitalized cases of COVID-19 with comorbidities or those developing typical respiratory symptoms upon home isolation in order to prevent their progress to severe illness.

2. Methods

This study was conducted in Ihnasia, Al-Wasiti, Fashn, and Beba Hospitals, Beni-Suef, Egypt. The study protocol was approved by the Research Ethical Committee of the Faculty of Pharmacy Beni-Suef University (REC-H-PhBSU-20010). This retrospective study was performed at hospitals selected for isolation of mild and moderate COVID-19 cases with comorbidities or those developing typical respiratory symptoms upon home isolation to prevent the disease progression to severe illness.

Their data were classified into seven parts: comorbidities, chronic medication before hospital admission, symptoms of COVID-19 before and during hospitalization, clinical features, laboratory findings on hospital admission, complications during hospitalization, as well as worst laboratory values during hospitalization, hospital stay, and the outcomes. The patients were classified into three categories based on their age: 20-40, 40-60, and 60-80 years old. This classification was done to detect any possible relationship between age and symptoms of COVID-19, CT findings, complications, type of oxygen therapy used during hospitalization, and the final treatment outcome.

SPSS Advanced Statistics version 22.0 was used to analyze the data (SPSS Inc., Chicago, IL). Numerical data were expressed as mean and standard deviation or median and range. The frequency and percentage of qualitative data were used. A Chi-square test was conducted to investigate the relationship between qualitative variables. For non-normally distributed quantitative results, the Mann-Whitney test (non-parametric t-test) was used to compare any two classes. The Kruskal-Wallis test (non-parametric ANOVA) was used to compare any three classes. The Spearman's rho method was used to test the association between numerical variables. Many of the experiments were two-tailed. A p value of 0.05 was

deemed significant.

3. Results

The observational data of comorbidities, chronic medication before admission, symptoms of COVID-19 before and during hospitalization, as well as chest radiograph or CT scan findings are shown in **Table 1**.

Table 1. Descriptive statistics of comorbidities, chronic medication before admission, symptoms of COVID-19 before and during hospitalization, and chest radiograph or CT scan findings

Demographic	Response	Number	Percentage (%)
Gender	Male	43	48.9
	Female	45	51.1
Comorbidities			
Cardiovascular disease	None	83	94.3
	Myocardial infarction	1	1.1
	Transient ischemic attack	1	1.1
	Atrial fibrillation	1	1.1
	Chronic heart failure	2	2.3
Hypertension	No	65	73.9
	Yes	23	26.1
Gastrointestinal problems	No	81	92
	Peptic ulcer	3	3.4
	Hepatic disease	4	4.5
Diabetes	No	80	90.9
	Yes	8	9.1
Malignant tumor	No	88	100
	Yes	0	0
Chronic nervous system diseases	No	88	100
	Yes	0	0
Chronic respiratory disease	No	88	100
	Yes	0	0
Renal disease	No	88	100
	Yes	0	0
Connective tissue disease	No	88	100
	Yes	0	0
Chronic medication before admission			
Chronic anticoagulant	No	84	95.5
	Warfarin	1	1.1
	Edoxaban	2	2.3
	Rivaroxaban	1	1.1
Antiplatelets	No	63	71.6
	Aspirin	25	28.4
ACEI	No	66	75
	Yes	22	25

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	Response	Number	Percentage (%)
Chronic medication before admission			
ARB	No	85	96.6
	Yes	3	3.4
Statin	No	53	60.2
	Atorvastatin	23	26.1
	Simvastatin	10	11.3
	Rosuvastatin	2	2.3
Chronic NSAID	No	88	100
	Yes	0	0
Immunosuppressant	No	86	97.7
	Yes	2	2.3
Antidiabetic	No	80	90.9
	Oral medication	4	4.5
	Insulin therapy	4	4.5
COVID treatment before admission	No	35	39.8
	Antibiotic	31	35.2
	Antibiotic-steroid	11	12.5
	Antibiotic-chloroquine	6	6.8
	Chloroquine-steroid-antibiotic	4	4.5
	Antiviral-antibiotic	1	1.1
Symptoms of COVID-19 before and during hospitalization			
Fever	No	10	11.3
	Yes	78	88.7
Cough	No	4	4.5
	Yes	84	95.5
Shortness of breath	No	8	9.1
	Yes	80	90.9
Myalgia	No	14	15.9
	Yes	74	84.1
Confusion	No	32	36.4
	Yes	56	63.6
Headache	No	33	37.5
	Yes	55	62.5
Sore throat	No	10	11.3
	Yes	78	88.7
Rhinorhea	No	73	83
	Yes	15	17
Chest pain	No	37	42
	Yes	51	58
Diarrhea	No	71	80.7
	Yes	17	19.3

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	Response	Number	Percentage (%)
Symptoms of COVID-19 before and during hospitalization			
Nausea and vomiting	No	54	61.4
	Yes	34	38.6
Anosmia	No	33	37.5
	Yes	55	62.5
Dysgeusia	No	31	35.2
	Yes	57	64.8
Chest radiograph or CT scan findings			
Unilateral pneumonia	No	80	90.9
	Yes	8	9.1
Bilateral pneumonia	No	8	9.1
	Yes	80	90.9
Multiple mottling and ground-glass opacity	No	3	3.4
	Yes	85	96.6

A total of 88 (43 male patients) confirmed COVID-19 patients admitted to the hospitals from June 2020 to September 2020 were included in this study. All of them were alive upon discharge from the hospital. Mild to moderate cases who suffered from some comorbidities included patients who had cardiovascular disease (5.6%), hypertension (26.1%), peptic ulcer (3.4%), hepatic disease (4.5%), and diabetes mellitus (9.1%).

Some patients were using chronic medication before admission, including chronic anticoagulants (4.5%), antiplatelet therapy (aspirin) (28.4%), angiotensin-converting enzyme inhibitors (ACEIs) (25%), angiotensin II receptor blockers (ARBs) (3.4%), statins (39.8%), immunosuppressants (2.3%), and antidiabetics (9%). Most of the patients (60.2%) received COVID-19 therapy before admission.

The most common symptoms of COVID-19 were fever (88.7%), cough (95.5), shortness of breath (90.9), myalgia (84.1%), confusion (63.6%), headache (62.5%), sore throat (88.7%), rhinorrhea (17%), chest pain (58%), diarrhea (19.3%), nausea and vomiting (38.6%), anosmia (62.5%), as well as dysgeusia (64.8%).

For chest radiograph or CT scan findings, 9.1% of the patients had unilateral pneumonia, 90.9% had bilateral pneumonia, and 96.6% had multiple mottling and ground-glass opacity.

The relationship between age and symptoms, chest radiograph findings, treatment during hospitalization, and complications during hospitalization are shown in **Table 2**. There was no significant relationship between age and chest radiograph or CT findings. In addition, there was no significant relationship between age and some symptoms, such as fever ($p = 0.304$), cough ($p = 0.529$), shortness of breath ($p = 0.79$), myalgia ($p = 0.939$), confusion ($p = 0.401$), sore throat ($p = 0.242$), diarrhea ($p = 0.727$), nausea ($p = 0.097$), anosmia ($p = 0.334$), and dysgeusia ($p = 0.7$).

However, there was a significant association between age and some symptoms, such as headache ($p = 0.005$), rhinorrhea ($p = 0.013$), and chest pain ($p = 0.007$).

In regard to oxygen use, 81.8% of the patients received oxygen therapy before admission. After admission, all the patients required oxygen therapy. Some of the patients (14.8%) used high flow oxygen, but there was no significant relationship between the need for high flow oxygen and age ($p = 0.183$). There was a significant correlation between the need for positive airway pressure (CPAP) and age ($p = 0.008$).

Out of the 88 patients, two patients (2.3%) developed complications during hospitalization, of which

one developed cardiovascular complication and the other developed pulmonary embolism.

Table 2. Relationship between age and symptoms, chest radiograph findings, treatment during hospitalization, and complications during hospitalization

	Response	Age			*p* value
		20-40	40-60	60-80	
Symptoms of COVID-19 before and during hospitalization					
Fever	No	7	1	2	0.304
	Yes	38	26	14	
Cough	No	3	1	0	0.529
	Yes	42	26	16	
Shortness of breath	No	5	2	1	0.79
	Yes	40	25	15	
Myalgia	No	7	4	3	0.939
	Yes	38	23	13	
Confusion	No	14	10	8	0.401
	Yes	31	17	8	
Headache	No	12	17	4	0.005
	Yes	33	10	12	
Sore throat	No	7	3	0	0.242
	Yes	38	24	16	
Rhinorhea	No	35	27	11	0.013
	Yes	10	0	5	
Chest pain	No	26	8	3	0.007
	Yes	19	19	13	
Diarrhea	No	36	21	14	0.727
	Yes	9	6	2	
Nausea	No	28	13	13	0.097
	Yes	17	14	3	
Anosmia	No	20	9	4	0.334
	Yes	25	18	12	
Dysgeusia	No	21	6	4	0.7
	Yes	24	21	12	
Chest radiograph or CT scan findings					
Unilateral pneumonia	No	40	24	16	0.376
	Yes	5	3	0	
Bilateral pneumonia	No	5	3	0	0.376
	Yes	40	24	16	
Multiple mottling	No	1	2	0	0.356
	Yes	44	25	16	
Oxygen therapy at diagnosis	No	9	4	3	0.857
	Yes	36	23	13	

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	Response	Age			*p* value
		20-40	40-60	60-80	
Treatment during hospitalization					
Oxygen therapy	No	0	0	0	-
	Yes	45	27	16	
High flow oxygen	No	37	22	16	0.183
	Yes	8	5	0	
CPAP	No	35	23	7	0.008
	Yes	10	4	9	
Complications during hospitalization					
Cardiovascular complication	No	45	27	16	0.103
	Yes	0	0	1	
Pulmonary embolism	No	45	27	16	0.103
	Yes	0	0	1	
Outcome	No	45	27	16	0.103
	Yes	0	0	0	

The correlation between pre- and post-hospital admission in relation to COVID-19 laboratory tests is shown in **Table 3**. After treatment, there was a significant increase in lactate dehydrogenase (LDH) ($p < 0.001$) and ferritin ($p < 0.001$), but a decrease in hemoglobin ($p < 0.001$), D-dimer ($p < 0.001$), and platelets ($p < 0.001$).

There was a significant decrease in total leucocyte count (TLC) comparing pre- and post-hospital admission ($p < 0.001$). The mean TLC level pre-admission was 7.3×10^9/L, the mean highest TLC level post-admission was 7.37×10^9/L, and the mean lowest TLC level post-admission was 6.1×10^9/L.

There was a significant decrease in neutrophil count ($p < 0.001$) comparing pre- and post-hospital admission. The mean neutrophil count pre-admission was 5.3×10^9/L, the mean highest neutrophil count post-admission was 6.1×10^9/L, and the mean lowest neutrophil count post-admission was 4.5×10^9/L.

Other than that, there was a significant increase in lymphocyte count comparing pre- and post-hospital admission ($p < 0.001$). The mean lymphocyte count pre-admission was 1.5×10^9/L, the mean highest lymphocyte count post-admission was 1.7×10^9/L, and the mean lowest lymphocyte count post-admission was 1.2×10^9/L.

The mean length of hospital stay was 12 days. There was no significant relationship between hospital stay and erythrocyte sedimentation rate (ESR) ($p = 0.346$) as well as C-reactive protein (CRP) levels ($p = 0.318$) comparing pre- and post-admission. However, there was a significant relationship between hospital stay and D-dimer level ($p = 0.05$).

Table 3. Correlation between laboratory tests before and after treatment

Parameter	Number of patients (%)	Response		*p* value
		Mean± SD	Range	
Platelet level				
Pre-admission	88 (100%)	238.8±74	135-513	< 0.001
Post-admission	88 (100%)	222.9±66	1.28-16.53	
Hemoglobin level				
Pre-admission	88 (100%)	12.3.8±1.5	9-15.7	< 0.001
Post-admission	88 (100%)	12.2±1.4	9-15	
D-dimer level				
Pre-admission	86 (97.7%)	388.8±234.2	7.1-960	< 0.001
Post-admission	86 (97.7%)	664.5±281.4	56-1460	
LDH level				
Pre-admission	78 (88.6%)	261.4±191.8	113-472	< 0.001
Post-admission	77 (87.5%)	309.1±177	186-1702	
Ferritin level				
Pre-admission	88 (100%)	388.8±254.8	9-891	< 0.001
Post-admission	86 (97.7%)	686.2±498.2	9-4722	
TLC level				
Pre-admission	88 (100%)	7.3±2.6	2.9-16.5	< 0.001
Post-admission (Highest)	88 (100%)	7.37±2.55	3.1-16.5	
Post-admission (Lowest)	86 (97.7%)	6.1±1.97	2.8-12.9	
Neutrophil count				
Pre-admission	88 (100%)	5.3±2.1	0.9-12.5	< 0.001
Post-admission (Highest)	88 (100%)	6.1±1.9	1.6-12.5	
Post-admission (Lowest)	86 (97.7%)	4.5±1.6	1.3-9.3	
Lymphocyte count				
Pre-admission	88 (100%)	1.5±0.9	0.6-8	
Post-admission (Highest)	88 (100%)	1.7±0.66	0.8-3.8	< 0.001
Post-admission (Lowest)	86 (97.7%)	1.2±0.5	0.6-3.1	

4. Discussion

In this study, the management of hospitalized COVID-19 cases with comorbidities or those developing typical respiratory symptoms upon home isolation was reported [7]. From the study, elderly patients were more likely to develop complications, such as cardiovascular complications and pulmonary embolism, compared to younger patients [7-12].

More attention should be paid to the effect of COVID-19 on patients with chronic comorbidities and the avoidance of drug-drug interaction between the use of chronic medication and the treatment used for COVID-19 [3,10,13]. In this study, cardiovascular disease, hypertension, and diabetes were considered risk factors for severity, affecting the survival rate when treating severe cases [14,15].

Alike other studies, fever, cough, shortness of breath, myalgia, confusion, headache, sore throat, rhinorrhea, chest pain, diarrhea, nausea and vomiting, anosmia, as well as dysgeusia were considered common symptoms of COVID-19 [12, 16-18].

All the patients in this study were alive upon discharge, and they did not develop severe illness. This may be due to the fact that most of the patients (60.2%) received COVID-19 treatment before admission

and 81.8% of them received oxygen therapy prior to admission. Early management of COVID-19 aids in lowering the probability of disease progression to severe illness [17]. There were some delays in the admission to hospitals due to the slow onset of typical respiratory symptoms or their use of home oxygen therapy [18,19]. An early initiation of oxygen therapy may slow down the disease progression in patients [16]. In this study, the patients required higher levels of oxygen or positive airway pressure, but invasive mechanical ventilation was not necessitated; only high flow oxygen and CPAP were used by the hospitals. Some patients experienced gastrointestinal tract (GIT) symptoms, such as diarrhea (19.3%) and nausea and vomiting (38.6%), long before the appearance of respiratory symptoms. These patients with GIT symptoms should be treated with the COVID-19 treatment protocol rather than waiting for respiratory symptoms to manifest.

Similar to a previous study, the increase in TLC and the decrease in lymphocyte count were found to be associated with COVID-19 [15]. A significant association between low platelets and COVID-19 was also discovered. The increase in neutrophil count can be explained by the stimulation of neutrophils and neutrophil-mediated innate immune responses as a result of viral infection [20].

In this study, the results showed a decrease in hemoglobin and an increase in ferritin during hospitalization. This could be due to the release of free iron following the interaction between SARS-CoV-2 and hemoglobin molecules, resulting in high ferritin levels in COVID-19 [21].

The elevation of ESR and CRP may be related to the abnormal chest findings in all the patients. Although most of the patients in this study were considered as having mild or moderate illness, upon testing for D-dimer, almost all of them were found to have values of more than the normal value of less than 0.5 μg/ml. According to the findings of a study of 183 patients with SARS-CoV-2 infection, patients with severe disease have nearly 3.5 times higher D-dimer values [22,23].

High LDH levels have been closely linked to COVID-19. This strong link between LDH and COVID-19 can explain why this enzyme is considered a marker of lung damage [17] and that SARS-CoV-2 primarily infects the lower respiratory tracts [24,25].

5. Conclusion

Hospitals with limited-resource in Egypt have proven effective in the management of hospitalized mild and moderate cases of COVID-19 with comorbidies. Most of the cases did not progress to severe illness, and the patients were alive upon discharge. Early management of COVID-19 delays the disease progress to severe illness and improves patients' survival rate. In addition, treating COVID-19 or using oxygen therapy at home may delay the need for hospitalization in mild or moderate COVID-19 cases. Old age is related to headache, rhinorrhea, chest pain, and the need to use positive airway pressure.

Disclosure statement

The authors declare no conflict of interest.

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