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Original Article

Analysis of Pharmacotherapy Costs and Outcome of Treatment of Hospitalized Patients with COVID-19

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Abstract

The COVID-19 pandemic has significantly affected people's lives and healthcare systems worldwide. Therefore, it is important to determine its effects on the economic and health sectors. This study aimed to calculate and analyze the costs and outcomes of COVID-19 treatment, including mortality and recovery, to improve health system planning. This cross-sectional descriptive study analyzed the costs and consequences of COVID-19 treatment in one of the largest referral training centers for patients in Lorestan province, Iran. The study examined hospital documents from the beginning of January to the end of December 2022. The results showed that the recovery rate of patients was approximately 87%, and the average cost per patient was 161 USD. More than 70% of this cost was related to medication and hospital bed expenses. Lopinavir was the most prescribed medication, and Immunoglobulin and Remdesivir had the highest cost share among all medication expenses. Given the significant proportion of medication and hospitalization expenses, it is recommended that the new approach to prescribing medications and managing patient care should be centered around standardized treatment protocols and home-based care. This is particularly crucial in developing countries with limited resources and clinical evidence. It is important to note that the calculation of standard treatment costs has limitations and should be interpreted cautiously.

Keywords: Cost, Medicine, Pharmacoeconomic, Management, Outcome, Treatment, Covid-19, Hospitalized patients, Lopinavir, Immunoglobulin, Remdesivir.

1. Introduction

The COVID-19 pandemic began in December 2019 in China [1, 2] and quickly spread worldwide, affecting all countries and regions [3, 4]. Iran was one of the countries with high prevalence at the beginning of the outbreak [5], with the first cases identified in the city of Qom [6]. This disease has significantly impacted various social and economic aspects of people's lives, causing changes in their incomes and lifestyles [7, 8]. The spread of the coronavirus and the increasing number of patients and

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complications have imposed high direct and indirect costs on patients, hospitals, health systems, and governments [9-11]. The direct treatment costs vary depending on the severity of the disease, the number of infected people, underlying conditions, and length of hospital stay [12, 13]. International studies show that the clinical costs of treating COVID-19 patients are significantly higher than treating other infectious diseases, possibly due to the higher severity of the disease and the higher rate of hospitalization and stay in the ICU [13-15]. The high costs of treating diseases and the high prevalence of COVID-19 have imposed additional pressure on health systems and hospitals [16-19]. Therefore, identifying and accurately estimating diseases' burden and treatment costs is essential for health policymakers and decision-makers to allocate limited resources optimally [20]. This study aims to estimate the direct costs of treating COVID-19 in hospitals, focusing on analyzing medicine costs, which are always considered an important factor in causing costs [21-23].

2. Materials and Methods

This cross-sectional descriptive-analytical study aimed to examine the total costs and outcomes of COVID-19 patients hospitalized in Shahid Rahimi Hospital, a teaching hospital affiliated with Lorestan University of Medical Sciences. The hospital is one of the largest inpatient referral centers in Lorestan province, located in Khorramabad city, the province's capital. The study included patients who met the inclusion criteria, which involved not having any underlying diseases, not being transferred from other centers, and being non-ambulatory.

This study was conducted retrospectively at the end of 2022 by accessing the hospital information system (HIS). The system includes all clinical, financial, and demographic information of patients. The researchers had access to all the information of the patients' files admitted from the beginning of January to the end of December 2022. in contrast, it maintains the confidentiality of the information. The hospital information system is a tool that allows healthcare providers to manage patient information, including medical history, test results, and treatment plans.

The costs of all patients were extracted from medical and accounting documents to analyze the direct medical costs of hospitalized COVID-19 patients from the service provider's perspective. The costs included the cost of hospitalization, consumables, nursing services, visits, consultations, medicine, EKG, laboratory, CT scan, ultrasound, radiology, miscellaneous and medical services, and technical rights. The total costs were calculated based on the Iranian Rial currency, and due to Iran's economic conditions and high exchange rate fluctuations, all expenses are reported in Iran's national currency. The exchange rate of the Rial against the US dollar (USD) was 350,000 when writing this manuscript to facilitate the presentation of international reports. Hence, it is important to mention that the cost was calculated during the study period, taking into account the significant fluctuations in the exchange rate in Iran at that time.

During the year, approximately 3,035 COVID-19 patients were admitted to the hospital, and about 50% of these patients, which is nearly 1,500 patients per year, met the inclusion criteria. All patients admitted to the

hospital with a positive test were included in the study, and an average of 125 patients per month was calculated based on the fluctuation of patient visits during different months. The variables studied included age, sex, length of hospitalization, treatment outcome (recovery and death), total cost, and medication costs. Since the prevalence of the disease fluctuated in different epidemic waves during the year, all patient information during the year 2022 was examined, and the data were presented as a monthly average. Finally, all the collected data were subjected to statistical analysis using SPSS 22 and Excel software. Also, appropriate statistical tests such as T-tests, Mann-Whitney tests, and other statistical tests were employed according to the type of variables and the research purpose.

3. Results and Discussion

The study found that the average age of the COVID-19 patients under study was 55.6 years, and the average length of hospitalization was 8.1 days. Most of the hospitalized patients were covered by social security insurance and Iranian insurance (a type of government insurance), accounting for 40% and 37%, respectively. Additionally, 52.9% of the patients were male. The outcome of their treatment revealed that 86.8% of the patients were cured (**Table 1**).

Table 2 shows that the average treatment cost for each hospitalized COVID-19 patient was the most significant cost factor related to medication costs, accounting for 39.73% of the total, followed by bed costs, which accounted for 35%.

Table 3 shows that Lopinavir was the most prescribed medicine among hospitalized COVID-19 patients, with 95% of patients receiving this medication.

Table 1. Demographic variables of hospitalized patients**.**

Quantitative variables	**Total**	**Average**	**Standard Deviation**
Age (year)	55.6		17.7
Hospitalization period (day)	8.1		4.6
Qualitative variables			
Frequency (patients)	**Total**	**monthly average**	**Percentage**
	1488	124	8.3
Insurance			
No insurance	24	2	1.61
Social security	600	50	40.32
Health service	552	46	37.10
Armed forces	216	18	14.52
Other	96	8	6.45
Gender			
Male	792	66	53.23
Female	696	58	46.77
Treatment outcome			
Cured	1296	108	87.10
Death	192	**16**	12.90
ICU admission			
No	1236	103	83.06
Yes	252	21	16.94

In contrast, remdesivir was prescribed to only 5% of patients, indicating the lowest prescription rate among hospitalized patients. The highest prescribed dose was Favipirovir, with 32 doses, followed by Lopinavir, with 23 doses. The lowest prescribed dose was associated with beta interferon and hydroxyl chloroquine, averaging three doses per patient. This means that the frequency of the prescribed drug dose per patient during hospitalization is an important metric to help healthcare providers ensure that patients receive the correct medication and dosage. Among the patients prescribed medication, the highest share of cost was related to immunoglobulin medication, accounting for 53.56%, followed by Remdesivir medication, accounting for 37.63%.

Table 2. Cost factors of treatment for patients**.**

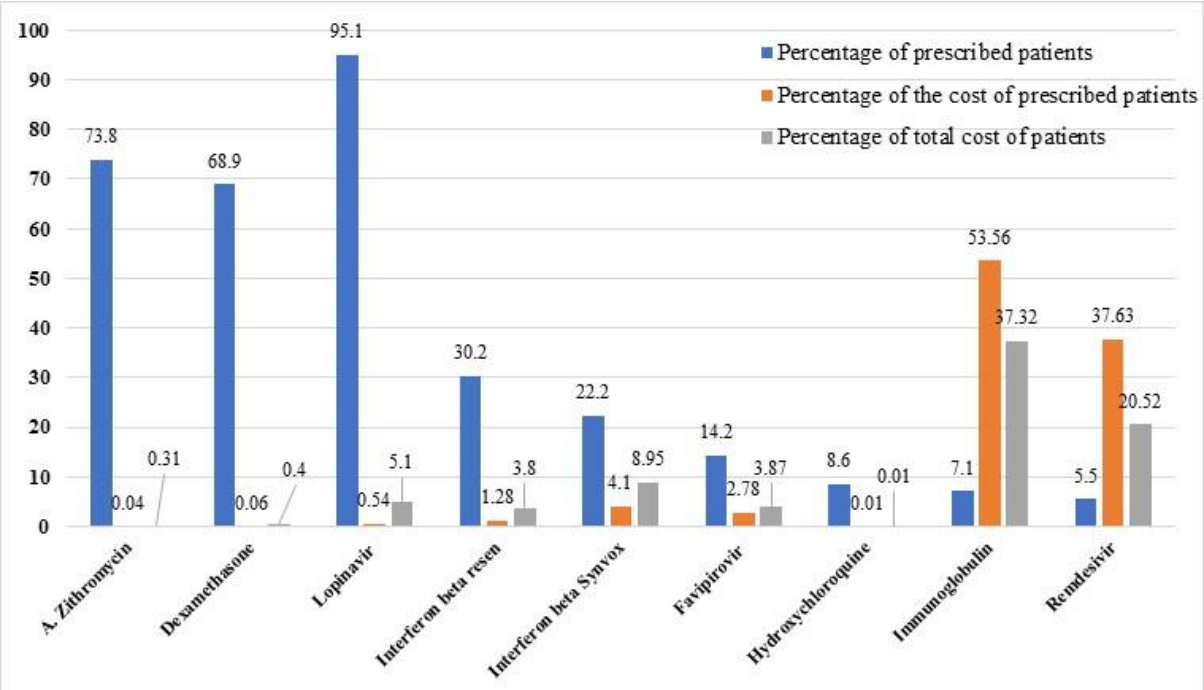
Cost factors	Total Cost (USD)	Cost per patient (USD)	Cost per patient (Rails)	Percentage
ICU bed	29,611	19.9	6,953,164	12.03
Normal bed	56,693	38.1	13,330,105	23.07
Consumables	7,589	5.1	1,790,737	3.1
Nursing Services	5,059	3.4	1,198,849	2.07
Visit	15,624	10.5	3,687,250	6.38
Counseling	5,952	4	1,393,179	2.41
Medicine cost	97,613	65.6	22,953,893	39.73
ECG	595	0.4	139,340	0.24
Laboratory	17,112	11.5	4,018,633	6.96
CT Scan	2,530	1.7	600,253	1.04
Sonography	446	0.3	90,370	0.16
Radiology	149	0.1	34,147	0.06
Medical services	446	0.3	96,162	0.17
The Technical Rights of Pharmacists	298	0.2	72,677	0.13
Total resource utilization Total Patient (1488)	239,568	--	--	100
Average resource utilization per patient	--	161	56,358,759	--

Table 3. Cost of medical items for hospitalized patients**.**

Medicinal items	percentage of prescription	frequency of the prescribed dose	Cost Medication in prescribed patients (Rial)	Cost of Medication (USD)	%	Total medicin ecost of all patients (Rial)	Cost of Medication (USD)	%
Azithromycin	73.8	8	97,235	0.3	0.04	71,805	0.2	0.31
Dexamethasone	68.9	9	132,217	0.4	0.06	91,128	0.3	0.40
Lopinavir	95.1	23	1,230,964	3.5	0.54	1,170,36	3.3	5.10
Interferon beta recigen	30.2	3	2,891,128	8.3	1.28	871,786	2.5	3.80
Interferon beta Synvox	22.2	6	9,268,438	26.5	4.10	2,053,31	5.9	8.95
Favipirovir	14.2	32	6,278,152	17.9	2.78	888,600	2.5	3.87
Hydroxy chloroquine	8.6	3	14,761	0.0	0.01	1,272	0.0	0.01
Immunoglobulin	7.1	11	121,052,261	345.9	53.56	8,566,77	24.5	37.32
Remdesivir	5.5	4.3	85,055,556	243.0	37.63	4,710,76	13.5	20.52
Total			226,020,712	645.8	100	4,528,08	12.9	19.7

Graph 1 showed that lopinavir, azithromycin, and dexamethasone were the most commonly prescribed medicines for COVID-19 patients, with many prescriptions. The cost of these medicines was meager and even negligible. The graph did not show their values clearly because they were less than one percent. In contrast, immunoglobulin and remdesivir medicines cost significantly more than other medications. The cost of these medicines is substantial, especially when considering the frequency of their prescription.

Table 4 shows a statistically significant difference between age and treatment outcome (P=0.001) in COVID-19 patients, with a higher death rate observed in patients with a higher average age.



Graph 1. Distribution of prescription and cost of medicinal items for hospitalized patients.

Table 4. Comparing the main study variables in different subgroups**.**

	ICU*		Treatment outcome		Sex	
	Yes	**No**	**Death**	**Cured**	**Female**	**Male**
Age (Year)	59.67	54.76	67.04	53.86	57.02	54.34
P (t-Test)	0.050		0.001		0.170	
Length of hospitalization (Day)	11.91	7.33	8.97	7.99	8.15	8.09
P (t-Test)	0.001		0.33		0.92	
Medicine cost (Rial)	69,624,514	13,238,076	40,391,199	20,295,013	18,955,929	26,510,222
Cost –USD**	198.9	37.8	115.4	58.0	54.2	75.7
P (Mann-Whitney U)	0.001		0.025		0.535	
Total cost (Rial)	152,877,073	37,981,346	107,842,205	50,144,977	53,253,521	61,804,125
Cost -USD	436.8	108.5	308.1	143.3	152.2	176.6
P (Mann-Whitney U)	0.001		0.001		0.750	

Additionally, a statistically significant difference was found between the duration of hospitalization in the ICU and the normal ward (P=0.001). Patients hospitalized in the ICU had a longer total hospitalization duration than those in the normal ward. The study also examined the relationship between medication costs and the overall cost of hospitalization regarding treatment outcomes (P=0.001) and length of stay in the ICU (P=0.001) and identified statistically significant differences. The costs were higher in the groups of patients who died later and in patients who were also admitted to the ICU.

The findings from Table 1 indicated that most of the patients were men with adequate insurance, mostly in their middle years.

The results showed (**Table 2**) that the average treatment cost of each hospitalized COVID-19 patient was about 161 USD, with

medicine costs being the largest cost factor, accounting for about 40% of the total costs. In the next rank, inpatient bed costs, including intensive and ordinary beds, accounted for 35% of the total expenses. These two cost items included about two-thirds of the total expenses of the patients. However, other studies have reported different results, with more than 40% of the total costs being allocated to the bed and the cost of medicine and equipment being second. In other studies, the cost of treating hospitalized COVID-19 patients has been estimated to range from 1500 to 2000 dollars [13, 18, 22]. In Ghafari Darab's study in Iran, the estimated direct medical expenses were about 171 USD per person, with around 41% related to intensive and general care beds and about 28% related to the costs of medicine and medical consumables [18]. The significant difference between medicine costs, bed costs, and other cost items may be due to the time-consuming process of treating COVID-19 and using different medicines. Another reason may be that the prescription of medicines is not based on treatment protocols, which increases the cost and leads to unreasonable medicine prescriptions [22].

Table 3 showed that lopinavir, azithromycin, and dexamethasone were the most prescribed medicines for COVID-19 patients. Favipiravir and lopinavir were the most prescribed doses. These medicines are commonly used to treat COVID-19 and are included in treatment protocols [24, 25]. The costs of immunoglobulin and remdesivir medicines accounted for the largest share of the total medicine costs, with about 90% among prescribed patients and about 57% among all patients. Evidence suggests that using remdesivir for non-ventilated patients and dexamethasone for ventilated patients is likely to be cost-saving by reducing ICU days compared to standard care [23]. However, considering the high price of these medicines compared to other medicines, it is important to ensure that their prescription is reasonable and based on the prescription protocol. With optimal management of the prescription of these medicines, medicine costs can be significantly reduced, and as a result, the total cost of hospitalized patients can also decrease. In studies, the combined use of medicines has been emphasized to increase the effectiveness of the treatment, with the effectiveness of dexamethasone in reducing the hospitalization time in the ICU being greater with the prescription of remdesivir [21, 23, 26]. It has been recommended that economic evaluation studies be conducted to choose medicines with greater effectiveness and lower cost [2, 17, 27].

Dexamethasone is the most cost-effective strategy for moderate and severe COVID-19 infections and has the least strain on the budget. In contrast, remdesivir alone is unlikely to be a cost-effective treatment for COVID-19[26, 28, 29]. Immunoglobulin has shown its clinical effectiveness on critically ill patients with COVID-19, and there may be a relationship between the effectiveness of immunoglobulin and the severity of the disease [30, 31]. However, it is important to use this medicine correctly and rationally, considering its high costs, and it should be prescribed to patients who need it [18, 22]. Most of the hospitalized COVID-19 patients were older adults, and most of the patients with COVID-19 were men, with

about one-fifth of the patients hospitalized in intensive wards. The cured rate was reported to be around 87 %(Table 1), which is relatively similar to the results of other studies [5]. Age has always been considered an important factor in the investigation of the prevalence and treatment of COVID-19, as old age is a significant risk factor that increases the length of hospitalization in the ICU and mortality. In this study, an average of 17% of patients were transferred to the ICU, and people with a higher average age had more hospitalizations in the ICU, resulting in a higher death rate in people with an older average age. Studies have emphasized the need for economic evaluation studies to choose medicines with greater effectiveness and lower cost [16, 17]. Using medicines based on standard treatment protocols can prevent medication errors in treatment and significantly contribute to reducing medicine costs.

Table 4 showed that the medicine costs and total costs of COVID-19 patients who died were significantly higher than those of cured patients. The complex and acute condition of these patients, which requires more care, maybe the most important reason for these higher costs. As a result, they have had more medical and pharmaceutical services, which has led to death. These costs are significantly higher in people who are hospitalized in intensive wards. These results are consistent with the results of other studies that indicate the high impact of prolonged hospitalization costs in increasing the health system's total costs and burden of diseases [11, 18, 32]. Due to the contagious nature of COVID-19 and its significant treatment costs, it is recommended that governments prioritize prevention over expensive treatments to prevent high costs in hospitals [3]. Economic evaluation studies should be used to determine more cost-effective medicines for prescribing to COVID-19 patients for the optimal use of medicines [2, 23]. To better manage the administration of medicines, it is important to use medicines based on standard treatment protocols to prevent errors in treatment and significantly contribute to reducing medicine costs. Since the length of stay of patients in the hospital is the basis for the increase in all costs of hospitalized patients, it is recommended that patients be discharged after removing the initial risks of the disease and continue other treatment measures at home. This not only reduces treatment costs but also reduces the spread of the disease. Therefore, the results of this research and evidence-based reviews in the field of macro-management of the health system can provide useful information for managers and health policymakers in decision-making. Using evidence and considering limited resources and unlimited needs should lead to the optimal allocation of resources for people in need and the promotion of justice. It is important to note that Iran's insurance policies and payment systems differ from other countries, so each country should implement reforms according to its structures.

4. Conclusion

This research indicates a very high share of medicine and hospitalization costs for COVID-19 patients. Therefore, the optimal management of these two expenses through the rational use of medicines based on protocols such as immunoglobulin and remdesivir and reducing

the length of hospitalization through home care leads to a significant reduction in the costs of patients and hospitals.

Conflict of interest

The authors declare to have no conflict of interest.

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