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Original Article

Hospitalization Costs of Patients with Covid-19: A Study in Tehran University of Medical Sciences

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Abstract

Introduction: The present study was carried out to analyze the costs involved with COVID-19 in one of the largest hospitals in Iran.

Methods: In this descriptive study, the total costs of hospitalization in Imam Khomeini Hospital affiliated to Tehran University of Medical Sciences for COVID-19 confirmed patients were analyzed until April 17, 2020. Data were extracted by reviewing patient record bills, and analyzed using descriptive and analytical statistics in SPSS 21.

Results: Data related to 1324 patients with COVID-19 were analyzed. Totally, 32.4% of all hospitalized patients had comorbidities, and 13.7% required intensive care and were admitted to the ICU. The average cost per hospitalized patient was 33,121,029 Rials (US $ 209.22), but this average had a high standard deviation (66,936,158 Rials, US $ 422.82). There was a significant difference in costs based on the length of stay (P=0.000), ICU hospitalization (P=0.000), presence of comorbidities (P=0.002), age (P=0.002) and gender (P=0.002), but the results of path analysis showed that only the variables of length of stay and hospitalization in the ICU had a direct effect on the costs and other factors had indirect effects.

Conclusion: COVID-19 is imposing significant costs on the health system, a significant proportion of which belongs to the length of hospital stay and the need to intensive care units. Directing resources to expand timely diagnostic capacity and manage disease in the early stages can both reduce the financial burden of providing highly costly inpatient services.

Keywords: COVID-19, Health care costs, Cost of illness, Direct service costs

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Introduction

Over the past decades, there has been a significant reduction in mortality and disability due to respiratory infectious diseases worldwide, so that DALY attributable to this group of diseases per 100,000 population of about 5700 years in 1990 decreased to about 2,000 years in 2017 (1). Despite these developments, the people of the world have witnessed the outbreak of some severe respiratory diseases and their significant effects in recent years. On December 31, 2019, an outbreak of a respiratory disease was reported in China (2) and the world is currently experiencing the pandemic of COVID-19 which is a member of a larger family of coronaviruses called severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) (3). This virus is the seventh coronavirus that has been proven to infect humans and the third coronavirus that has emerged in the last two decades and has caused multinational outbreaks and significant mortality and disability (4). Coronavirus is a major pathogen that primarily targets the human respiratory system. Previous outbreaks of coronaviruses include severe acute respiratory syndrome (SARS)-CoV and Middle East respiratory syndrome (MERS) CoV, which were previously considered as threatening public health concern (5).

The characteristic of COVID-19 is a respiratory syndrome with varying degrees of severity ranging from mild lower respiratory distress syndrome to interstitial pneumonia and acute respiratory distress syndrome. Although SARS-CoV-2 belongs to the same group of beta-coronas responsible for SARS and MERS, the new virus appears to cause a milder

infection. COVID-19 is not significantly different from SARS in terms of clinical features; however, its fatality rate (2.3%) is lower than SARS (9.5%) and much lower than MERS (34.4%). The base rate of COVID-19 transmission is still debated (6), but there is strong evidence that this disease can be transmitted by people with only mild illness or even pre-symptomatic stage (7). The rate of transmission of COVID-19 (2 to 2.5) is probably slightly higher than SARS (1.7 to 1.9) and higher than MERS (less than 1) (6). Thus, it appears to be more demanding to limit than SARS and MERS, which were spread only by people with clinical signs (7). Due to the rapid spread of COVID-19, the world community is facing a crisis unprecedented in the last 75 years. This disease has become more of a human crisis than a health crisis (8). From the onset of the disease until October 4, 2020, the number of diagnosed cases worldwide has reached 34, 880, 434 cases, and 1,030,738 deaths have been reported (9).

In addition to mortality and morbidity, coronaviruses are also accompanied with high economic consequences. The results of a study showed that if SARS continued from 2003 to 2004, its global costs would reach more than $ 40 billion (10). An examination of the costs of MERS in Saudi Arabia showed that the direct cost of treatment per patient varied from $1248.41 to $75987.95, depending on the severity of the disease (11). COVID-19 is currently causing double shocks in both health and economy (12). According to the World Bank, this pandemic will lead to a reduction of 2.50 to 4.57 percent in global exports and a deviation of -2.09 to -3.86 percent in total world economy (13). According to the International Monetary Fund forecasts, as the result of this pandemic, the world economy will shrink by about 3%, which is considerably more serious than the financial crisis of 2008-2009 (14). The direct costs of COVID-19 treatment are higher than other common infectious diseases because COVID-19 is more likely to require hospitalization than other pathogens. Estimates show that even only if the costs related to acute infection are considered and follow-up costs are not taken into account, the direct costs of a symptomatic case of Covid-19 are remarkably higher than other common infectious diseases. For example, the average cost of a case of covid-19 is four times that of a case of the flu and 5.5 times that of a case of pertussis (15). In Canada, the cost of Covid-19-related hospitalizations is estimated at $15,000 for patients who have not been admitted to the ICU and more than $ 50,000 for patients admitted to the ICU (16). A study conducted at a general center in Germany indicated that the cost of hospitalized patients with Covid-19 varied between EUR 900 and EUR 53000 per patient (17).

On February 19, the Iranian Ministry of Health announced the death of two people due to COVID-19. The rate of spread of this disease in the country was so high that it spread to all provinces by March 5 (18). Until October 4, 2020, 468000 confirmed cases of COVID-19 and 26,746 relevant deaths have been reported in Iran (9). The outbreak of this disease in Iran and facing mortality, morbidity and its social and economic consequences occurred at a time when the country was suffering severe sanctions imposed by the United States, which has affected Iran's economy and households. Previous studies have shown that economic sanctions lead to significant economic downturns, rising inflation, declining government revenues, public investment, employment, job security, economic stability, and households' income and their purchasing power. Consequently, they have reduced the well-being of all households of urban and rural income groups, weakened living standards, and reduced the government's ability to support vulnerable groups (19). According to the results of *Noy & Doam's* study, the economic risks of the COVID-19 outbreak, especially in large parts of sub-Saharan Africa and Southeast Asia, Iran, Afghanistan and South Asia are higher than other parts of the world (20). Although Iran has one of the most resilient health systems in the region, it is currently affected by the negative consequences of sanctions and the resulting overall economic lockdown that directly and indirectly disrupts all aspects of prevention, diagnosis and treatment and can defeat the country in the short term in the face of crisis. Lack of medical, pharmaceutical, and laboratory equipment such as protective gowns and required drugs can increase the epidemic burden and the number of casualties (21). The present study aimed to analyze the inpatient costs caused by the COVID-19 outbreak in order to estimate financial resources required to battle the outbreak. Notably, with the spread of the epidemic, a main concern is the burden of disease on the health care system and the financial resources to support it (22). It is, thus, necessary to estimate this financial burden and plan to provide the required financial resources for the health system in Iran under sanctions, which is facing a significant reduction in available financial resources.

Methods

In this descriptive study, the treatment costs of patients admitted with COVID-19 in Imam Khomeini Hospital

affiliated to Tehran University of Medical Sciences were investigated. Cost and other data related to the total number of patients who were admitted to the hospital with confirmed COVID-19 between February 20 and April 27, 2020 were extracted from the patients' records, so all members of the study population entered the study, and no sampling method was adopted. All cost items of patients' records were divided into 5 main groups: hoteling and nursing, medicine and medical supplies, doctor's visit and consultation, diagnostic services and other costs, and cost information provided by these areas. According to the Central Bank report, the average selling price of one US dollar in April 2020 in the market of Tehran was 158,306 Rials (23). Cost data based on this exchange rate is converted to USA dollars 2020. In addition to cost data, some other non-cost information such as age, gender, comorbidities (diabetes, hypertension, asthma and cancer), length of hospital stay, and the intensive care unit admission were also collected. Data were analyzed through SPSS 21, using descriptive statistics (mean, standard deviation and percentage) and analytical statistics including Mann-Whitney U, Kruskal-Wallis tests, and path analysis.

Results

During the study period, a total of 1324 cases with a definitive diagnosis of COVID-19 were admitted to Imam Khomeini Hospital in Tehran. About 32.4% of all hospitalized patients had comorbidities, and 13.7% required intensive cares and were admitted to the ICU (Table 1).

The average cost per hospitalized patient was US $ 209.22. However, the standard deviation of this rate is extremely high (std.dev=US $ 66,936,158) and the cost has varied from a minimum of 1 US$ to a maximum of US $ 1775.43 (Table 2). We divided the patients by their cost into four quintiles and represented cost variation in these quarters in Figure 1. When people are divided into cost quarters and the cost structure is compared in different quarters, it is observed that people in the fourth quarter are the cause of increasing costs and creation of a significant dispersion in costs. It means that less than 25% of people are the cause of the costs which are higher than the average. In other quarters, both the median and mean of the costs are lower, and there is less dispersion.

The major proportion (51.6%) of the costs of patients with COVID-19 in the hospital has been hoteling and nursing care, followed by diagnostic services (16.4%), doctor's visit and consultation (15.1%), and medicine and medical supplies (14.9%). The costs of hoteling and nursing cares, in addition to being the main cost item in the records of these patients, were more dispersed in their nature than other cost groups, and while the average cost of this group is US $ 106.20, its standard deviation is US $ 206.91.

According to the results of Kolmogorov-Smirnov test, the distribution of the total costs was not normal, so Mann-Whitney U and Kruskal-Wallis tests were run to evaluate the significance of the difference between costs in the groups in terms of contextual variables. As can be seen in Table 3, there is a significant difference between different groups of individuals based on the variables of age (P=0.002), comorbidities (P=0.002), stay in ICU (P=0.000), and length of stay (P=0.000). The p-value of the gender variable did not differ significantly until confirmation (P=0.058).

Table 1: Distribution of the patients' underlying variables

Variable	Groups	Frequency	Percent
Gender	Male	820	60.5%
	Female	514	37.9%
	Unknown	22	1.6%
Age	<30	64	4.7%
	30-60	661	48.7%
	>60	609	44.9%
	Unknown	22	1.6%
Comorbidity	Yes	439	32.4%
	No	896	66.1%
	Unknown	21	1.5%
Admission in ICU	Yes	186	13.7%
	No	1024	75.5%
	Unknown	146	10.8%
Length of stay	<10 Days	1184	87.3%
	10-20 Days	119	8.8%
	>20 Days	32	2.4%
	Unknown	21	1.5%

Table 2: Costs of the major groups of medical services in patients' bills

Type of service		Cost		Share of each service from the total cost (%)	
		Mean	Std. deviation	Mean	Std. deviation
Hoteling and nursing	IRR	16812220	32755976	51.6	15.7
	US$	106.20	206.92		
Medicines and consumable medical supplies	IRR	9224614	30000090	14.9	13.3
	US$	58.27	189.50		
Visit and Consultation	IRR	2739788	3162049	15.1	9.0
	US$	17.30	19.97		
Diagnostic services	IRR	3363361	4812411	16.4	12.8
	US$	21.24	30.39		
Other services	IRR	981044	4101648	1.8	4.1
	US$	6.19	25.90		
Total	IRR	33121029	66936158	-	-
	US$	209.22	422.82		

Table 3" Comparison of the patients' cost according to the underlying characteristics

Variable	Groups	Mean		Std. deviation		P value
		IRR	US $	IRR	US $	
Gender	Male	35084070	221.62	72138289	455.69	0.058
	Female	30039684	189.76	57670643	364.30	
Age	<30	17603337	111.20	27214635	171.91	0.002
	30-60	31000203	195.82	61487636	388.41	
	>60	37096203	234.33	74849632	472.82	
Comorbidity	Yes	37873003	239.24	72347696	457.01	0.002
	No	30792773	194.51	64031890	404.48	
Admission in ICU	Yes	132007668	833.88	130069192	821.63	0.000
	No	15697670	99.16	20899592	132.02	
Length of stay	< 10 Days	16369171	103.40	20336367	128.46	0.000
	10-20 Days	126165976	796.98	90816252	573.68	
	> 20 Days	306928854	1938.83	155843568	984.45	

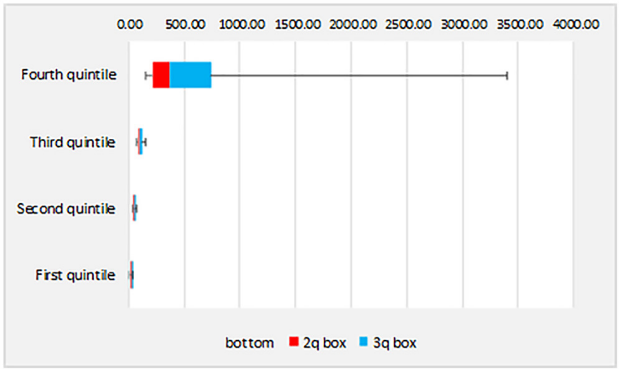

Figure 1: Cost dispersion of patients with COVID-19 in different quarters

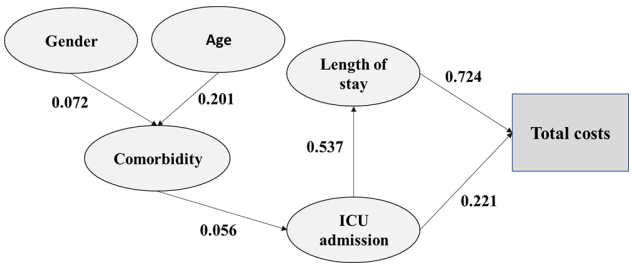

Figure 2: Path of the effect of underlying variables on the costs

Path analysis was employed in order to analyze the effect of different factors on patients' costs. As can be seen, the variables of the length of stay and admission in the ICU played major roles in determining the variation in costs. The length of stay had only a direct effect with a coefficient of 0.724. However, the variable of admission in ICU had a direct effect with a coefficient of 0.221 and had an indirect effect on the costs through extending the length of stay of patients with a coefficient of 0.338 (Figure 2). The impact of underlying variables on costs has been indirect, and they have exerted their impact on the costs by increasing the likelihood of disease exacerbation and ICU admission. In Table 4, the extent of direct, indirect and total effects of variables on the treatment costs of patients with COVID-19 is illustrated.

Table 4: Results of regression of patients' underlying variables on the total cost of providing inpatient treatment services

Variable	Direct effect	Indirect effect	Total effect
Length of stay	0.724	-	0.724
Stay in the ICU	0.221	0.338	0.559
Existence of comorbidities diseases	-	0.034	0.034
Age	-	0.006	0.006
Gender	-	0.002	0.002

Discussion

According to the results of the study, the average cost per hospitalized patient with Covid-19 was 33,121,029 Rials (US$209.22), while in the study of *Ghaffari Darab et.al*, this rate was estimated 59,203,409 Rials (24), which is about 80% more than the estimated cost in this study. The reason for this difference may be due to differences in the sample size, study time period, and composition of sample members. Given that there have been significant differences in the cost of health care delivery unit worldwide in non- coronavirus circumstances (25), it may not be useful to compare the costs in different countries. However, making such comparisons can provide an understanding about the severity of the financial effects on the health systems of other countries. *Bartsch et.al* estimated the average direct medical costs of Covid-19 patients in the United States at $3,045 (22). According to the results of the study of *Khan.et.al,* this rate in Saudi Arabia in the public sector and the ICU was 42,704 and 79,418 Saudi Rials, respectively (26). An estimate of the cost of 70 patients with Covid-19 in China showed that the average cost of treatment per patient was US $6827 (27). Compared to the average cost reported per patient with Covid-19 in other countries, the cost in dollars in this study seems low, but it should be noted that this difference could be due to the high exchange rate of the dollar against the Iranian currency, which has been created due to unfavorable economic conditions caused by sanctions. Over the past two years, the exchange rate of foreign currencies in the Iranian market has increased exponentially, so that the exchange rate of the US dollar in Tehran market has increased from 50,083 Rials in April 2018 to 158,306 Rials in April 2020, i.e. it has tripled (28). In order to provide a more accurate comparison, it can be pointed out that the minimum daily wage in 2020 in Iran has been set at 611,800 Rials (29), which is about $3.9.

In recent decades, the outbreak of various diseases has threatened communities and took many lives. Outbreak response management plays a key role in reducing mortality rates and overall costs of the health care system. Among all the parameters affecting the performance of the outbreak response system, available resources are central parameters. This becomes critical when the number of infected people who need such resources increases significantly. Under such circumstances, system costs and mortality rates may soar (30). A review of the daily epidemiological reports of Covid-19 of the Iran Ministry of Health shows that from May 20 to October 16, 2020, the mean hospitalization rate of confirmed Covid-19 cases was 44%, and 187,453 Iranians have been hospitalized in this time period. For the time period before May 20, there are no separate statistics of inpatients and outpatients, but the total number of confirmed cases from the beginning of the outbreak until this date has been 104,691 cases. Given that before May 20, the hospitalization rate of definitive cases was 44%, the total number of confirmed hospitalization cases due to Covid-19 was 234,190 persons. Therefore, the total cost of hospitalization due to Covid-19 in Iran until October 16 is estimated at 7756.6 billion Rials (about 49 million US dollars), which is equivalent to about 0.6% of the total costs of the Iranian health system in 2017 (31).

Studies showed that the range of cost fluctuations and their dispersion is significantly high. By dividing the patients into different quarters in terms of total cost and cross-comparing the cost structure in these quarters, we can see that in the first to third quarters, both the median cost and the dispersion of costs are significantly lower than those in the fourth quarter. This means that a small proportion of patients, located in the highest cost quarters, increases the average cost of total patients. Path analysis of the factors affecting costs shows that the length of stay in the hospital directly and stay in the ICU with the dual effect of direct and indirect are the main factors affecting higher costs.

As shown in Table 3, the average cost of people staying in the ICU is about 10 times that of people who did not receive intensive care. In the study population of the present study, 13.7% of hospitalized patients have used intensive care, while in the study of *Ghaffari Darab et.al*, this rate was 7% (24). Some studies have suggested that about one-third of people infected with SARS-CoV-2 are in critical condition of the disease and require intensive care (32). At the

height of the outbreak in Wuhan in February, nearly 20,000 patients with COVID-19 were admitted in the hospital at the same time, 10,000 of whom were in critical conditions (17). Others report that approximately 5% of COVID-19-confirmed cases require intensive care (33). As the world responds to the growing pandemic of COVID-19, a shift in global public health priorities reveals fundamental gaps in the health systems around the world, one of which is lack of ICU beds to care patients in critical condition COVID-19.

While intensive cares capacity was limited in low- and middle-income countries before the pandemic, even countries with high-resource health systems currently face shortages of ICU beds. A review of data from 182 countries shows that the number of ICU beds per 100,000 population varies from 0 to 59.5 beds, and this number is less than 5 beds per 100,000 people at least in 96 countries. Among these, Iran is ranked among the countries with limited capacity of ICU beds (1-4.9 beds per 100,000 population) (34), and this issue can create many challenges in managing severe cases considering the increasing number of cases in the country (9). Cases exceeding the capacity of health care systems may lead to lower quality of cares, including lack of access to the ventilators and, consequently, elevation in the case-fatality ratio.

As shown in Figure 2, admission in the ICU, besides having a direct effect on costs, raises costs by extending the length of stay. This, in turn, greatly affects the costs among all variables. Perhaps, this is why hoteling and nursing costs are the largest component of the patients' costs, which constitutes on average 51.6% of the patients' cost. In *Ghaffari Darab's* study, this item also had the largest share of costs, so that the total costs of public beds, intensive care and nursing services were 43% of total costs (24). Notably, in the study of *Li X-Z*, the highest costs were related to medicines (27). In this study, the majority of patients (87.3%) had a stay length of less than 10 days, but a small group had a stay length of more than 20 days (2.4%). A study conducted in Germany showed that although the average length of stay in hospital for all patients was 14.3 days, this amount varied from 11.9 to 29.9 days (35). The estimates of the present study showed that the average cost in the group with a stay length of more than 20 days was about 19 times that of the group with a stay length of less than 10 days.

The variable of comorbidities had some effects on costs through increasing the probability of hospitalization in the intensive care unit. Generally, 32.4% of the patients studied in this study had different types of comorbidities. In the sample studied by *Ghaffari Darab et a*l., almost half of the patients suffered from at least one comorbidity (24). The results of the *Guan*'s study showed that among COVID-19 confirmed cases, patients with comorbidities had weaker outcomes than those without comorbidities, and larger number of comorbidity cases per person means weaker clinical outcomes (36). According to the study by *Yang et al*., comorbidities such as hypertension, cardiovascular disease, and respiratory disease are risk factors for COVID-19 disease exacerbation (37). According to a study by *Richardson et al*., the most common comorbidities among 5,700 patients with Covid-19 hospitalized in New York was hypertension, obesity, and diabetes (38). The results of meta-analysis performed by *Wang* showed that hypertension, diabetes, COPD, and cardiovascular and cerebrovascular diseases were the main risk factors for patients with Covid-19 (39).

Age and gender have also had little effect on the costs and they exert their influence on the costs indirectly and through increasing the probability of the presence of comorbidities in individuals. Most hospitalized patients were men in the age group of 30 to 60 years. *Richardson's* study also confirmed that among hospitalized patients with Covid-19, most were elderly men, or those with underlying hypertension and diabetes (38). In a study conducted in China, hospitalized patients were mostly men with a median age of 56 years, and 26% required inpatient care (40).

As mentioned, the Covid-19 outbreak has already imposed massive costs on the Iranian hospital system, and the disease response system must adapt to the financial shock caused by this disease in various ways. Ensuring a comprehensive response to the Covid-19 pandemic requires adequate public funding. Re-prioritizing public expenditures to strengthen the health and economic system requires timely measures by government leaders and a supportive public funding environment. To respond these new economic and financial constraints, adjustments must be made in both revenue and expenditure dimensions of the budget (41).

What was investigated in this study was only the costs of hospitalized patients and outpatient costs, excluding other costs dimensions imposed on the health system and the economy of the country. With regard to the unpredictable nature of this disease and its definitive treatment, the development of evidence in the field of epidemiological dimensions and its economic effects require appropriate decision-making and policy-making, and research efforts in this field should be continued.

Conclusion

The Covid-19 outbreak is imposing considerable costs on the Iranian health system. A significant portion of these costs are due to the length of hospital stay and the need to provide expensive cares in intensive care units. Directing resources to expand the capacity to timely diagnosis and management of the disease in the early stages can reduce both financial burden of providing intensive cares and the mortality rate of Covid-19 patients. It will also improve the life-threatening condition of the patients in other wards who require intensive cares.

Availability of Data and Materials

The datasets supporting the conclusions of this article are included within the article/tables. The raw data can be requested from the corresponding author on reasonable request.

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Authors' Contributions

All authors contributed to this study. Conception and design (RD, AA, AF & SD), Acquisition of data (RD, AN & NS), Analysis and interpretation of data (RD, SD), Drafting of the manuscript (RD & SD), Critical revision of the manuscript for important intellectual content (RD, AN, NS, AF, AAS & SD), Administrative, technical, or material support (RD). All authors have read and approved the manuscript.

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