An economic evaluation on the hospitalization and medication therapy in old COVID-19 patients: An experience from a tertiary center in Iran

Abstract

Aims: There are controversies on the treatment of old aged patients and patients with end-stage disease about the expenditures imposed on surveillance. The present health economic evaluation study was performed to find the cost-effectiveness of hospitalization and antiviral treatment of COVID-19 in old patients.

Materials & Methods: A health economic evaluation as a single center primary study with a cross-sectional design was performed in Firoozgar hospital, Tehran, Iran, during the second half of 2020. All the hospitalized cases of COVID-19 at 65 years of age and more were eligible for the study. The health outcomes were length of stay (LOS) and death. Cost-effectiveness was calculated using incremental cost-effectiveness ratio (ICER).

Findings: A total of 347 cases were studied. According to the median of the total bed-day cost of 36.141 dollars in ICU admitted patients as well as survival of 40.74% in these patients, 88.711 dollars were needed for survival of one patient, assuming that all the ICU-needed patients would die if lack of hospital admission. Considering all ward and ICU admitted patients, 44.854 dollars were needed to save one patient life.

Conclusion: The study results are generalizable merely to our own population. Hospitalization of old patients has a notable expenditure on our healthcare system. But ethically, we should admit all the patients who need admission. In order to generalize the results globally, further primary studies are needed.

Introduction

Like many other diseases, coronavirus disease of year 2019 (COVID-19) showed a heavy burden on societies and healthcare systems [1-4]. It seems that COVID-19 burden may be more in developing countries [5]. The burden of COVID-19 is described as "post-pandemic double burden" meaning that COVID-19 has an excessive burden on health system for management of non-communicable diseases resulting in a post-pandemic crisis [6].

Other than COVID-19, there will be some other similar pandemics in the future. Therefore, it is a critical issue to find an economic plan in such conditions. The experience of 28 countries showed that COVID-19 pandemics was a shocking event manifesting weak points of governments. The key elements of highly effective country responses were to activate comprehensive responses, adapt health system capacity, preserve health system functions and resources, and reduce vulnerability [7]. For such challenges of the COVID-19 era, economic issues are of great importance. Decision-makers should reach flexible policies that regard economic and ethical issues [8-12].

It is essential to know whether the policies are cost-effective. COVID-19 hospitalization is not an exception and there are economic issues [13, 14]. Among the aspects of COVID-19 burden, economic burden of COVID-19 is considerable [3, 15, 16]. For instance, it should be clear whether hospitalization of old COVID-19 patients is helpful and cost-effective. In addition, many drugs used in the management of COVID-19 have unclear rules. COVID-19 is not the first example of a challenge in the treatment of old aged patients. Senescence has always been a big challenge in health economics. Hence, economic issues are considered in the management of elderly diseases [17]. Cost payment for elderlies is not necessarily harmful to the governments. In the US, more than one out of five more than 65-year-old Americans live in high-risk regions of COVID-19, and many of them rely on earning. Therefore, it is considered economic insecurity [18]. It means that costing for old patients may result in enhancement of public health in old populations. An editorial emphasized adequate social and medical support for older adults regarding COVID-19 [19].

According to the controversies on the treatment of old aged patients and patients with end-stage disease about the costs imposed on surveillance and health system, the present health economic evaluation study was performed to find the cost-effectiveness of hospitalization and antiviral treatment of COVID-19 in old patients among Iranian cases.

Material and Methods

A health economic evaluation as a single center primary study with a cross-sectional design was performed based on the consolidated health economic evaluation reporting standards 2022 (CHEERS 2022) statement [20]. Our health economic analysis plan was established to find whether hospitalization and antiviral treatment of old COVID-19 cases were cost-effective. This study was approved by the ethics committee of Iran University of Medical Sciences with registration number IR.IUMS.FMD.REC.1399.827.

The present study was performed in Firoozgar hospital, Tehran, Iran, as a referral and tertiary center during the second half of 2020 through a simple random sampling. A health information system (HIS) was used for sampling and access to the data. All the hospitalized cases of COVID-19 at 65 years of age and more were eligible for the study. Confirmation of COVID-19 was through polymerase chain reaction (PCR) or typical involvement in chest computed tomography (CT) scan. The perspective of the study was from healthcare providers. The time horizon of the study was limited to the hospitalization period in which the health outcomes were length of stay (LOS) in day and death as a binary outcome. Due to the limited time horizon, discount rate was not used.

Total bed-day costs during admission and also costs of antiviral medications were calculated. The costs were in Iranian Rial (IRR), and then they were converted to US dollar based on the integrated currency trading system of Iran (locally called NIMA) at the time of data analysis (May 2022). Thus, each dollar was considered as 250000 IRR.

Cost-effectiveness was calculated using incremental cost-effectiveness ratio (ICER). ICER was calculated as the following for death and LOS outcomes, respectively. For death outcome, drugs with a significant absolute risk reduction (ARR) were eligible for ICER calculation. Calculation of ICER based on number needed to treat (NNT) has been previously used by other researchers [21, 22]. For LOS outcome, drugs with a significant decrease in LOS were eligible for ICER calculation. Stata14 (Stata Corp. LLC, US) was used for data analysis.

$$ICER = \frac{\Delta C}{\Delta E} = \frac{Medication\ regimen\ cost}{ARR} = Medication\ regimen\ cost \times NNT$$

$$ICER = \frac{\Delta C}{\Delta E} = \frac{Medication\ regimen\ cost}{Decrease\ in\ LOS}$$

Findings

Demographic information

Of the admitted patients, 347 cases of over 65 years of age were selected for the study. A number of 173 patients (49.86%) were in the age range of 65-74, 69 patients (31.41%) were in the age range of 75-84, and 65 patients (18.73%) were 85 and more. Sex-wise, 145 patients (41.79%) were female and 202 patients (58.21%) were male. A number of 104 patients (29.97%) were ward admitted and 243 patients (70.30%) were ICU admitted.

In terms of diagnosis method, 8 patients (2.31%) were diagnosed only by PCR, and the rest, in addition to the positive PCR in chest CT scan were involved by COVID-19. Among the people who had involvement in their CT scans, the average involvement score was 13.09 (±7.01) from 25. For the number of hospitalizations (for any reason), each patient had an average history of 2 days of hospitalization (±3.07), the least of which was 1 hospitalization and the most of them was 29 hospitalizations.

In terms of frequency of underlying diseases, 42.94% had cardiovascular disease, 15.85% had lung disease, 14.12% had kidney disease, 3.17% had rheumatology disease, 59.94% had hypertension, 37.75% had diabetes mellitus, 12.96% had cancer, and 11.24% had a history of cerebrovascular events. For habits, 10.09% used cigarettes, 7.78% used opium, and one person used alcohol.

Regarding clinical symptoms, 28.53% had myalgia, 41.50% had fever, 71.76% had respiratory symptoms, 49.28% had weakness and lethargy, 25.65% had digestive symptoms, 15.85% had decreased level of consciousness, 5.76% had chest pain, and 3.46% had sweating. For admission time oxygen saturation percentage without using supplemental oxygen, its average was 88.63% (±7.36) that the lowest was 60% and the highest was 99%.

Regarding receiving general medications, 93.66% took antibiotics, 94.81% took proton pump inhibitors, 63.69% took interferon, 68.59% took hydroxychloroquine, and 88.86% took corticosteroids. Also, 13.54% took tocilizumab (actemra). For antiviral medications, 24.21% took favipiravir, 34.29% took remdesivir, 57.93% took sofosbuvir/daclatasvir, 20.46% took ledipasvir, 6.05% took lopinavir/ritonavir, and 5.48% took atazanavir/ritonavir.

Clinical outcomes

A total of 199 patients (57.35%) survived and 148 patients (42.65%) died. In terms of LOS, the mean was 11.40 (±7.01) days in which the mean of LOS at ward was 5.24 (±5.44) days and at ICU was 6.15 (±6.94) days.

Economic findings

The total bed-day cost of admission was calculated for the patients. The mean of the cost was 35.41 (±32.03) dollars with a right-skewed distribution (Table 1, Figure 1).

Table 1. Central and dispersion statistics for total bed-day cost of admission.

Cost (dollar)	Mean	Standard deviation	Minimum	Percentile 25%	Median	Percentile 75%	Maximum
All patients	35.407	32.028	2.096	11.528	25.724	48.636	223.726
Survived patients	29.475	30.745	4.192	8.384	17.063	38.614	223.726
Dead patients	43.383	32.086	2.096	20.502	33.185	60.312	179.282

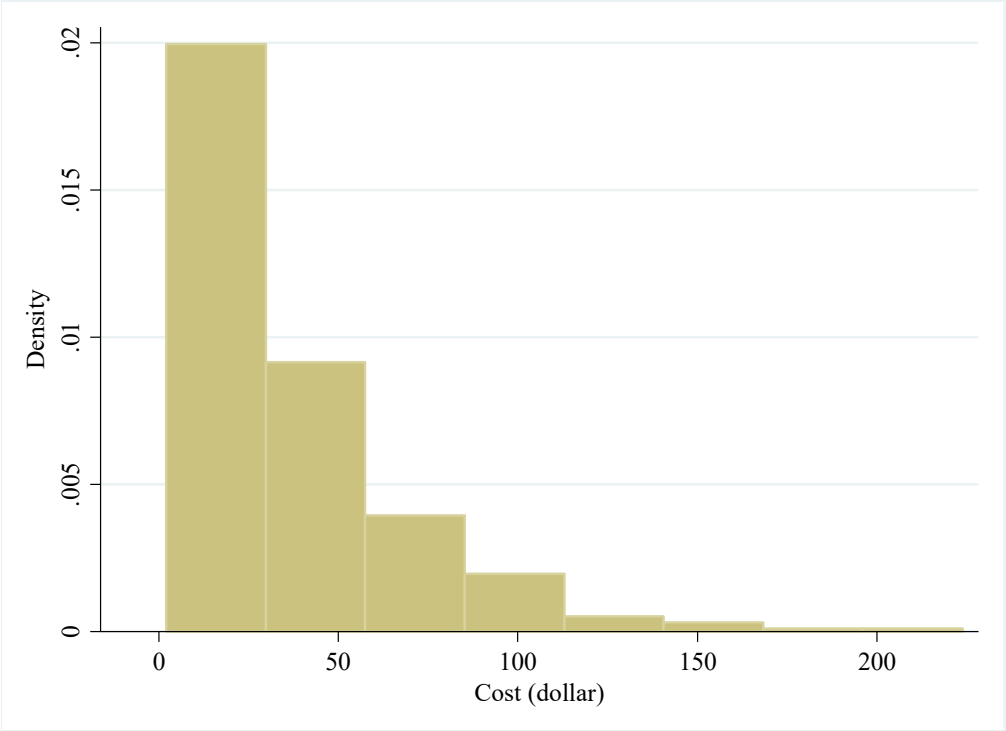

Figure 1. Histogram of total bed-day cost of admission.

Total bed-day cost was compared between survived and dead patients (Figure 2). The difference in median was 16.122 dollars. Based on Mann Whitney U test, dead patients had higher costs rank-wise ($P<0.001$).

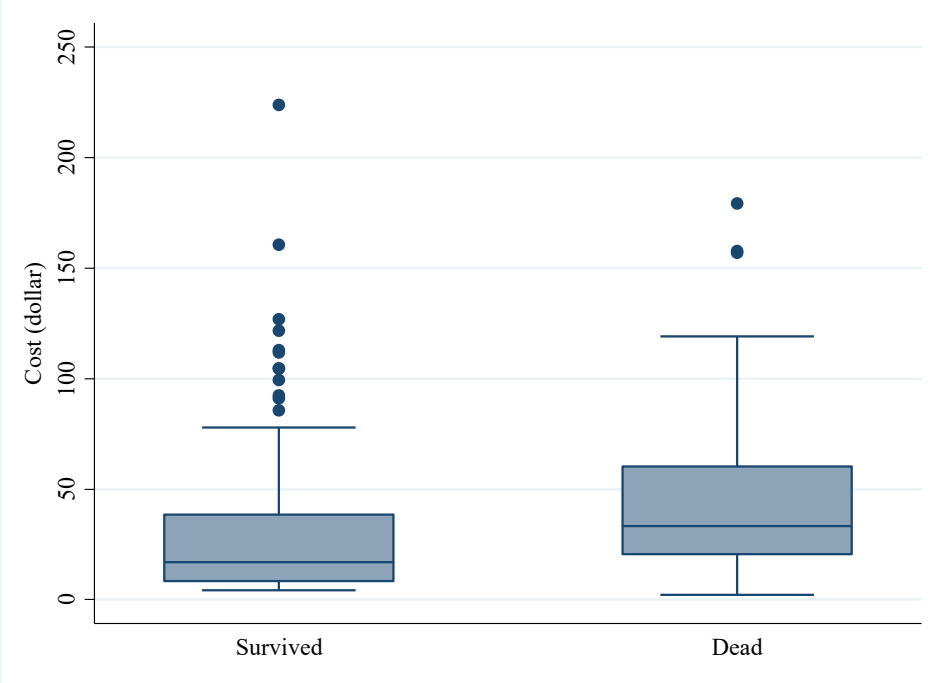

Figure 2. Box plot of total bed-day cost of admission divided by disease outcome.

For antiviral drugs, cross-table analysis was performed for death outcome in all possible conditions of drug-ward/ICU/total admission (not shown). Accordingly, favipiravir and atazanavir/ritonavir showed significant ARR at 95% confidence interval in ward admitted patients (Table 2).

Table 2. Economic evaluation of antivirals in reduction of death among ward admitted patients.

Medication	Statistic	Point estimation	95% confidence interval
Favipiravir	ARR	5.06%	0.22%-9.90%
	NNT	19.75	10.10-437.43
	ICER	395$	202-8748.6
Atazanavir/ritonavir	ARR	4.12%	0.17%-8.08%
	NNT	24.25	12.38-599.70
	ICER	33.135$	16.916-819.430

H0: ARR=0, H1: ARR>0.

LOS was compared between antiviral recipients and non-recipients among survived patients. No significant LOS reduction was observed, and therefore, ICER was not calculated.
According to the median bed-day cost of 36.141 dollars in ICU admitted patients as well as survival of 40.74% in these patients, 88.711 dollars were needed for survival of one patient, assuming that all the ICU-needed patients would die if lack of hospital admission. Considering all ward and ICU admitted patients, 44.854 dollars were needed to save one old aged patients' life assuming this logic.

Discussion

The present study was conducted to find the cost-effectiveness of COVID-19 management in old aged patients in Iran as our country has specific economic conditions. Regarding the cost-effectiveness of oral antiviral treatments, no antiviral medication was found that reduced mortality in ICU admitted patients of our population. Two medications were found that had significant ARR in ward admitted patients. Due to the approximate similar effectiveness of favipiravir and atazanavir/ritonavir and on the other hand, the lower cost of atazanavir/ritonavir, the more economical medication is suggested. However, considering these wide confidence intervals of NNTs and ICERs showing the wide range of uncertainty, we understand that our point estimations are not generalizable to the parameter of the population. Nevertheless, regarding cost-effectiveness of hospitalization, the self of hospitalization and ICU admission was helpful in indicated patients as bed-days cost was not high in Iran. In our culture, saving elderly life is of spiritual importance for families. On the other hand, their hospitalization brings overall high costs for our government. In such conditions, increasing out-of-pocket payments may be a solution to make a balance between these two facts.
As we mentioned, saving the life of elderlies and improving their quality of life in Iranian culture is a value. There were some studies in this regard performed before COVID-19 pandemics. Daddoust *et al.* (2018) investigated the vulnerability of the Iranian elderly in disasters as a qualitative study. They found that there were personal and social factors other than age that could affect this vulnerability to disasters [23]. Therefore, planning on these factors may be helpful and cos-effective.
Economic burden of COVID-19 is of great importance. An Iranian experience reported by Gaffari Darab *et al.* (2021) on 477 patients showed the direct and indirect costs of COVID-19. Their study included 100 number (21%) of patients with age more than 65 [24]. However, there was no comparison between the costs of elderly patients and other age groups. In the present study we directly calculated the costs of elderly patients.
A systematic review was performed by Rezapour *et al.* (2020) about the economic evaluation programs in COVID-19. They reviewed 23 studies based on CHEERS checklist. Most studies had used suspected-infected-recovered (SIR) model for outcomes. The most cost-effective actions were social distancing and screening tests. Only three studies had focused on treatment and vaccination [25]. In the present study, we investigated treatment in elderlies. In general, elderlies have always been noteworthy, even from the economic point of view as they are vulnerable and they have high mortality regarding COVID-19 [26]. Also, from the viewpoint of human rights, providing health and welfare for elderlies is necessary as most COVID-19 mortalities are at the age of 60 years and older[27].
Although we had some limitations, our study had enough novelty. During the literature search, we found no document investigating the health economics of COVID-19 in old people as a primary study. The most important limitation was that we did not have access to the patients who needed hospitalization, but they were not hospitalized, and this investigation was not ethically possible. Also, we did not have any control group from the younger population. In addition, we did not investigate the quality of life as an important factor in health economic studies.

Conclusion

As a single-center study in a tertiary hospital, the study results are generalizable merely to our own population. Briefly, hospitalization of old patients has a considerable expenditure on our healthcare system. But ethically, we should admit all the patients who need admission. In order to generalize the results globally, further primary studies are needed. Then the evidence may be generalizable to any similar pandemic in the future.

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