



Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

Elsevier hereby grants permission to make all its COVID-19-related research that is available on the COVID-19 resource centre - including this research content - immediately available in PubMed Central and other publicly funded repositories, such as the WHO COVID database with rights for unrestricted research re-use and analyses in any form or by any means with acknowledgement of the original source. These permissions are granted for free by Elsevier for as long as the COVID-19 resource centre remains active.



ScienceDirect

Contents lists available at sciencedirect.com
Journal homepage: www.elsevier.com/locate/vhri

Economic Evaluation

Diagnostic and Therapeutic Costs of Patients With a Diagnosis of Or Suspected of Coronavirus Disease in Iran



Hosein Ebrahimipour, PhD, Hassan Haghparast-Bidgoli, PhD, Shapour Badiee Aval, PhD, Seyed Javad Hoseini, PhD, Sara Jamili, PhD, Zahra Ebnehoseini, PhD, Marjan Vejdani, PhD, Amin Adel, PhD

ABSTRACT

Objectives: To understand the social and individual effects of the disease and make decisions on the allocation of health resources, it is necessary to understand the economic burden of coronavirus disease (COVID-19); however, there are limited data in this field. This study aimed to estimate diagnostic and therapeutic costs of patients with a diagnosis of or suspected of COVID-19 disease admitted to hospitals in northeast Iran.

Methods: This descriptive and analytical research was conducted as a retrospective study using the data collected from 2980 patients admitted to 30 hospitals from February to April 2020 in Iran. For data collection, an appropriate data capture tool was designed to record detailed resource use. A multivariate regression analysis was performed to examine the association between the treatment costs and sociodemographic, disease severity, and underlying diseases. Data were analyzed using Excel 2017 (Microsoft, Redmond, WA) and SPSS version 21 software (SPSS Inc., Chicago, IL).

Results: The inpatient costs per patient were Int\$416, of which 74% were paid by social health insurance systems, 19% by the government, and 7% by the patients. The largest cost components were hoteling (37%) and medicine (36%). The 4 subscales of age, sex, underlying disease, and severity predicted 48.6% of the cost variance.

Conclusion: Understanding the economic consequences of diseases can help policymakers to make plans to reduce out-of-pocket payments and make plans for funding. Since COVID-19 is a newly emerging disease and there is no definitive cure for the disease, the discovery of an effective medicine may alter medical costs and reduce the hospital length of stay, therefore significantly reducing treatment costs.

Keywords: Cost, COVID-19, Iran.

VALUE HEALTH REG ISSUES. 2022; 27:21–24

Introduction

Disease affects development and economic well-being in 3 main ways. The first way is direct as premature death and chronic disability due to disease lead to extensive economic losses in a community. Indirectly, disease also affects the investment of families for their children. The high cost of some diseases reduces the economic power of poor households to invest in children's education and health. Finally, disease has negative effects on investment and trade infrastructure. Increasing the share of the healthcare sector in the national budget reduces the share of other sectors, including industrial production and service sectors.^{1–3}

The evolution of coronavirus disease (COVID-19) and its economic impact is very unclear, making it difficult for policymakers to formulate appropriate macroeconomic policy and responses.⁴ A study used several scenarios to estimate the economic impact of COVID-19 disease in 30 countries. In a mild scenario, the impact of disease on gross domestic product (GDP) growth varies from 3% to 6%, depending on the country. Therefore, in the sample of 30

countries studied, we see an average decrease of 2.8% in GDP growth in 2020. In other scenarios, the impact on GDP growth can be more than 10% and in some countries, it may even reach more than 15%.⁵ Another study estimated that the real rate of GDP growth in the United States would be reduced by 5% for each month of the partial economic shutdown. This means that the economic cost in the first 2 months fighting the epidemic will be about \$2.14 trillion, which is surprisingly close to the static financial cost of the Coronavirus Aid, Relief, and Economic Security Act.⁶

On January 11, 2020, the first death from COVID-19 was reported in China and the diagnosis of positive cases in other countries such as Thailand, Japan, South Korea, and the United States was reported until January 20, and the transfer of disease from individuals to medical staff further complicated the situation.^{7–9} According to a report by the World Health Organization, the total number of people with COVID-19 was 10 357 662 individuals in July 1, 2020, and 508 055 individuals died in different countries. The countries with the highest number of cases were

the United States, Brazil, and Russia with 2.6, 1.4, and 0.65 million, respectively, and the Islamic Republic of Iran was ranked the 10th with 0.23 million infected individuals.¹⁰ Iran was the first country in the Middle East that experienced the spread of COVID-19.⁷ The first case of COVID-19 in Iran was observed on February 19 in Qom. Since then, COVID-19 has been spreading rapidly in Qom and other provinces of Iran.¹¹ This is the third coronavirus to develop in the last 2 decades that led to a multinational outbreak and significant transmission of complications and mortality.^{12,13} There are specific features for each of these outbreaks (severe acute respiratory syndrome [SARS], Middle East respiratory syndrome, and COVID-19), and the progressive prevalence of COVID-19 poses challenges similar to those observed during the prevalence of SARS and Middle East respiratory syndrome, and the lessons learned during those outbreaks can be utilized as well.¹⁴

A study in China showed that the direct medical costs of hospitalized patients with avian influenza were substantial and significantly above the annual per capita income of people in Jiangsu Province, China.¹⁵ Therefore, the identified influential factors should be considered when formulating relevant health insurance policies and allocating health resources. COVID-19 disease has spread tremendously, disrupting the capacity of the healthcare system in various countries and incurring high hospital costs.¹⁵ To realize the social and individual effects of the disease and decide on the allocation of health resources, it is necessary to understand the economic burden of COVID-19 disease; however, data are limited in this area. To fill this gap, the current study reports an estimate of the diagnostic and therapeutic costs of hospitalized patients with a diagnosis of and suspected of COVID-19 disease in the northeast of Iran.

Methods

This descriptive and analytical research was conducted as a retrospective study using the data collected from 2980 patients admitted from February to April 2020 to 30 hospitals (including 4 coronavirus referral hospitals) in Khorasan Razavi province in the northeast of Iran. Data from the present study are representative of patients from across the country, and generalizable to the patients referred to the hospitals after this study as well because the treatment protocols and tariffs for health services are the same across the country. The patients were identified based on the final diagnostic codes of U07.1 and U07.2 from the International Classification of Diseases, tenth revision. According to definitions presented in the Iranian Ministry of Health's protocol, the U07.1 diagnostic code was used for patients with COVID-19 with a positive PCR, and the U07.2 diagnostic code was used for patients with a diagnosis of COVID-19 having clinical symptoms and a positive computed tomography scan in favor of coronavirus and a negative PCR. Diagnostic and therapeutic care services were similar in both groups of patients.

The diagnostic and therapeutic services and their related costs were evaluated in 2 main stages: (1) identifying and measuring services and resources used, and (2) estimating the cost of the services and resources.¹⁶

In the first step, background information on the disease was reviewed and the steps needed to diagnose and treat COVID-19 were determined. Triangulation of 3 approaches was used to identify and measure a complete list of services and resource required by the patients, namely: (1) through examining the patients' medical records and hospital information system; (2) evaluation of care and treatment protocols for COVID-19 issued by the Ministry of Health and Medical Education; and (3) through an interview with an expert (expert opinion). A data capture tool was

developed to record data on services and resources used by patients. The validity of the tool was evaluated through experts' opinions (4 specialists and 1 methodologist), and its reliability was assessed using the parallel (peer-to-peer) method.

Using the data capture tool, the following information was extracted from the medical records of patients: medical record identification, age, type of insurance coverage, date of hospital admission, initial diagnosis and final diagnosis information, the severity of disease (based on the ward of admission, ie, general ward or intensive care unit [ICU]), reports on laboratory tests and diagnostic radiology services, type of treatment and supportive medications, presence or absence of an underlying disease, and length of stay in hospital. The list of diagnostic and therapeutic services required for patients with COVID-19 was used to collect data on the average rate of service received (the ratio of people receiving service to the total number of people surveyed).

In the second step, the cost of services and resources used by the patients were estimated. The cost of hoteling was estimated based on the tariffs approved by the Cabinet; the cost of medical and diagnostic services based on the 2019 Book of "Relative Value of Health Services;" the cost of medical supplies based on the average cost reported by the General Office of Medical Equipment; and the medicine cost based on the insurance price list portal and price coverage by the health insurance. The cost of nursing services was estimated to be 6% of the total cost of hoteling.

The data collected using the data capture tool was reviewed and entered into Excel 2007 software and analyzed using descriptive statistical techniques. Multivariate linear regression was used to analyze the relationship between sex, age, the severity of the disease and underlying disease/comorbidity, and the treatment cost. SPSS version 21 software (SPSS Inc., Chicago, IL) was used to analyze the data at a significance level of 0.05.

All costs were converted to Int\$ using the purchasing power parity conversion rate for Iran (1 Int\$ = 130 613 Iranian Rial).

Results

Appendix Table 1 in Supplemental Materials found at <https://doi.org/10.1016/j.vhri.2021.05.001> shows that out of all the patients studied, 412 were admitted to ICU and 2568 in a general ward. The patients have an average age of 56 years and 61% were male whereas 39% were female. A total of 94% of the patients were Iranian and the remaining 6% were from other nationalities. Regarding the source of payment/finance, the highest amount was related to the insurance organizations with a share of 74%, followed by the government with 19%, and patients' out-of-pocket with 7%.

The highest cost was related to hoteling with a mean value of 6.9 days that was estimated to be Int\$161.19. The hoteling cost along with costs of medication and laboratory tests accounted for about 80% of the total cost (Appendix Figure 1 in Supplemental Materials found at <https://doi.org/10.1016/j.vhri.2021.05.001>).

The costs of patients with underlying diseases were 6% higher than the costs of other patients. Costs of patients whose illness was more severe and needed ICU services were more than 5 times higher than the other patients. In male patients, the costs were 10% higher than the costs in female patients. Among the age groups, the patients in the age group of 65 to 74 years had the highest average cost per patient and the patients in the age group of 0 to 17 years had the lowest average cost per patient (Appendix Table 2 in Supplemental Materials found at <https://doi.org/10.1016/j.vhri.2021.05.001>).

The highest medicine cost per patient was for intravenous immunoglobulin with a mean of 1.2 units of medicine and a total

cost of Int\$100.3 per patient. The most common antiviral medicines used were hydroxychloroquine and lopinavir/ritonavir (Kaletra), with the mean of 14 and 15.6 units of medicine per patient, respectively. The most commonly used antibiotic was azithromycin, with a mean of 12.3 units per patient. In addition, among anticoagulants, heparin with a mean of 10.7 units was also among the medicines with the highest dose per patient. The overall total cost of medicine and medical supplies per patient were Int\$157.5 and Int\$27.4, respectively (Appendix Table 3 in Supplemental Materials found at <https://doi.org/10.1016/j.vhri.2021.05.001>).

The most common tests per patient were urea, sodium, potassium, and creatinine (Cr) test. A specific reverse transcription-PCR test is used to diagnose COVID-19 for definitive diagnosis, and it was performed with a mean of 1.04 units per patient, with a maximum of 2 cases (Appendix Table 4 in Supplemental Materials found at <https://doi.org/10.1016/j.vhri.2021.05.001>).

Chest computed tomography scans were performed for each patient at a cost of \$6.3. The average cost of imaging for the patients studied was \$10.5 per patient for 2.5 cases of imaging (Appendix Table 5 in Supplemental Materials found at <https://doi.org/10.1016/j.vhri.2021.05.001>).

The results of multivariate linear regression are shown in Appendix Table 6 in Supplemental Materials found at <https://doi.org/10.1016/j.vhri.2021.05.001>. The fitted model shows the variables included in the model (ie, age, sex, underlying disease, and severity of the disease) predict 48.6% of the cost variance. The results from the analysis show that the disease severity (ie, being admitted in ICU) was associated with higher costs.

Discussion

This study evaluated direct medical costs associated with hospitalization because of COVID-19 in Iran. The results show that the average direct cost of COVID-19 is about Int\$439 per patient, and considering its prevalence as reported by the World Health Organization on July 1, 2020, the financial burden of direct medical costs of COVID-19 in Iran is estimated to be Int\$100 million. Since the disease is a newly emerging disease, limited empirical data on the costs of the disease are available. In a study in the United States using the Monte Carlo simulation method, however, the direct cost of symptomatic COVID-19 disease was estimated at US\$ 3212.¹⁷ The results of the study showed that if 20% of the community would be infected by the disease, the direct cost of medical care is estimated at \$163.3 billion, indicating a high economic burden of the disease.¹⁷ The discrepancy between the results can be attributed to differences in the study approach, the type of costs estimated, and the different sampling patterns applied in this country.

When only the costs of acute infection are considered and not the costs of follow-up care after infection, the direct costs of a symptomatic COVID-19 disease are significantly higher than the costs of other common infectious diseases. For example, the average treatment cost for COVID-19 is 4 times higher than the symptomatic influenza¹⁷ and more than 5 times than that of pertussis.¹⁸

The major components of the COVID-19 treatment costs are related to hoteling (36.7%) and medicine and medical supplies (35%). Contrary to the present study, previous studies on SARS and avian influenza epidemics showed that the highest medical costs were related to medicines, which accounted for 66% of costs of SARS and 53% of costs of H7N9 influenza.^{15,19} One of the potential reasons for this difference could be due to the longer hospital stay

for patients with a diagnosis of COVID-19 compared with patients with a diagnosis of SARS and influenza. These studies have also shown that with the increasing severity of the disease, which prolongs the patient's stay in the hospital, the cost of hoteling, and patient accommodation will also increase. Moreover, admission to ICU increases the cost substantially.

In this study, 14% of patients who referred to the hospital were admitted to ICU. Global findings²⁰ show that about 80% of patients with COVID-19 have mild to moderate symptoms and about 15% of patients with severe symptoms need hospitalization. In 5% of cases, the condition becomes critical and may require admission to ICU. Hence, if in the present study, 20% of patients with COVID-19 disease would be referred to hospitals, about 3% of the patients require admission to ICU. This rate is less than the global findings. The results from the US modeling study shows that a 20% increase in the probability of patients with COVID-19 admission to ICU will increase the total cost to \$14 991.¹⁷

In the present study, the highest medicine cost per patient was related to immunoglobulin, which accounted for 63.07% of the total medicine costs, followed by antibiotics (with 13.9%), antivirals (3.75%), and other medicines (19.34%). In patients with influenza, however, immunoglobulin accounted for 10.4%, antibiotics for 20.8%, antivirals for 2.5%, and other medicines for 64% of total medicine costs.¹⁷

Based on the treatment protocols of the Iranian Ministry of Health, the necessary tests for diagnosis, determination of possible prognosis, and evaluation of the possibility of disease progression and evaluation of the performance of internal organs in hospitalized patients include the following daily tests: complete blood count, C-reactive protein, serum glutamic pyruvic transaminase, serum glutamic oxaloacetic transaminase, creatine phosphokinase, ferritin, alkaline phosphatase, and blood urea nitrogen/Cr. In addition, fibrinogen, international normalized ratio, prothrombin time, partial thromboplastin time, and D-dimer are performed every other day in patients in general wards, and daily in patients in the ICU. To check the risk of disease progression, lactate dehydrogenase, and troponin tests are performed at least once a day. In addition, urinalysis and urine protein to Cr ratio are prescribed in patients with symptoms of acute renal failure.²⁰ This study showed that the most common tests in patients examined included reverse transcription-PCR specialized test and complete blood count, C-reactive protein, venous blood gas, lactate dehydrogenase, urea, potassium, sodium, Cr, blood sugar, prothrombin time, and partial thromboplastin time, which are performed more than once for each patient.

In the present study, the costs associated with conducting the tests accounted for 7.9% of the total costs and were estimated at Int\$32.9 per patient. In a study of direct costs of influenza epidemics in 3 Chinese provinces, the average cost of laboratory tests was estimated at \$63, which is 14.9% of total direct costs of influenza,²¹ which is higher than the costs estimated in the present study. The difference may be attributed to differences in the type of tests, though the type and details of the tests are not mentioned in the study.

Limitations

This study focuses on direct medical costs and, therefore, does not include direct nonmedical costs and indirect medical costs that may be associated with COVID-19, including productivity losses owing to absenteeism, early mortality, as well as declining economic activity.

Conclusion

To prevent people from facing catastrophic health costs, health policymakers should cover the direct costs of COVID-19 by emphasizing the costs of hoteling and medicine. Since COVID-19 is a newly emerging disease and there is no definitive cure for it, the discovery of an effective medicine may alter medicine costs and reduce the length of hospital stay, and may result in substantially reduced total treatment costs.

Supplemental Material

Supplementary data associated with this article can be found in the online version at <https://doi.org/10.1016/j.vhri.2021.05.001>

Article and Author Information

Accepted for Publication: May 26, 2021

Published Online:

doi: <https://doi.org/10.1016/j.vhri.2021.05.001>

Author Affiliations: Social Determinates of Health Research Center, Mashhad University of Medical Sciences, Mashhad, Iran (Ebrahimipour, Jamili); Institute for Global Health, University College London, London, England, UK (Haghparsat-Bidgoli); Department of Complementary and Chinese Medicine, School of Persian and Complementary Medicine, Mashhad University of Medical Sciences, Mashhad, Iran (Aval); Department of Medical Biotechnology and Nanotechnology, School of Medicine, Mashhad University of Medical Sciences, Mashhad, Iran (Hoseini); Psychiatry and Behavioral Sciences Research Center, Mashhad University of Medical Sciences, Mashhad, Iran (Ebnehoseini); Student Research Committee, Mashhad University of Medical Sciences, Mashhad, Iran (Vejdani); Health Management and Economics Research Center, Health Management Research Institute, Iran University of Medical Sciences, Tehran, Iran (Adel).

Correspondence: Amin Adel, PhD, Health Management and Economics Research Center, Iran University of Medical Sciences, Tehran 1449614535 Iran. Email: a-adel@student.tums.ac.ir

Author Contributions: *Concept and design:* Ebrahimipour, Haghparsat-Bidgoli, Badiiee-Aval, Vejdani

Acquisition of data: Jamili, Ebnehoseini, Vejdani

Analysis and interpretation of data: Ebnehoseini, Adel

Drafting of the manuscript: Haghparsat-Bidgoli, Jamili, Vejdani, Adel

Critical revision of the paper for important intellectual content: Ebrahimipour, Haghparsat-Bidgoli

Statistical analysis: Jamili, Adel

Provision of study materials or patients: Hoseini, Ebnehoseini, Adel

Obtaining funding: Ebrahimipour

Administrative, technical, or logistic support: Badiiee-Aval, Hoseini

Supervision: Ebrahimipour, Badiiee-Aval, Hoseini

Conflict of Interest Disclosures: The authors reported no conflicts of interest.

Funding/Support: This work was supported by grants 990145 from the Mashhad University of Medical Sciences Foundation.

Role of the Funder/Sponsor: The funder had no role in the design and conduct of the study; collection, management, analysis, and interpretation of the data; preparation, review, or approval of the manuscript; and decision to submit the manuscript for publication.

Acknowledgment: The present paper was extracted from a research project that was approved by the Research Council of Mashhad University

of Medical Sciences with the registration code of 990145 and the ethics code of IR.MUMS.REC.1399.139.

REFERENCES

- Rice DP. Estimating the cost of illness. *Am J Public Health Nations Health.* 1967;57(3):424–440.
- Byford S, Torgerson DJ, Raftery J. Cost of illness studies. *BMJ.* 2000;320(7245):1335.
- Askarzade E, Adel A, Ebrahimipour H, Badiiee Aval S, Pourahmadi E, Javan Biparva A. Epidemiology and cost of patients with cancer in Iran: 2018. *Middle East J Cancer.* 2019;10(4):362–371.
- McKibbin WJ, Fernando R. The Global macroeconomic impacts of COVID-19: seven scenarios. CAMA Working Paper No. 19/2020. SSRN. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3547729. Published March 2, 2020. Accessed November 25, 2020.
- Fernandes N. Economic effects of coronavirus outbreak (COVID-19) on the world economy. IESE Business School Working Paper No. WP-1240-E. SSRN. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3557504. Published March 22, 2020. Accessed November 25, 2020.
- Makridis C, Hartley J. The cost of COVID-19: a rough estimate of the 2020 US GDP impact. Special Edition Policy Brief. SSRN. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3570731. Published April 6, 2020. Accessed November 25, 2020.
- Coronavirus disease (COVID-19): situation report –163. World Health Organization. https://www.who.int/docs/default-source/coronavirus/situation-reports/20200701-covid-19-sitrep-163.pdf?sfvrsn=c202f05b_2. Published July 1, 2020. Accessed November 25, 2020.
- Torretta S, Gaini LM, Pignataro L. Why Italian ENT physicians should be aware of SARS-CoV-2. *ACTA Otorhinolaryngol Ital.* 2020;40(2):152–153.
- Wang J, Wang Z. Strengths, weaknesses, opportunities and threats (SWOT) analysis of China's prevention and control strategy for the COVID-19 epidemic. *Int J Environ Res Public Health.* 2020;17(7):2235.
- Nguyen HC, Nguyen MH, Do BN, et al. People with suspected COVID-19 symptoms were more likely depressed and had lower health-related quality of life: the potential benefit of health literacy. *J Clin Med.* 2020;9(4):965.
- Moradzadeh R. The challenges and considerations of community-based preparedness at the onset of COVID-19 outbreak in Iran, 2020. *Epidemiol Infect.* 2020;148:e82.
- Nayeri ND, Taghavi T, Shali M. Ethical challenges in the care of emerging diseases: a systematic literature review. *Bioethics journal.* 2017;7(26):85–96.
- Talley AE, Bettencourt BA. A relationship-oriented model of HIV-related stigma derived from a review of the HIV-affected couples literature. *AIDS Behav.* 2010;14(1):72–86.
- Arabi YM, Murthy S, Webb S. COVID-19: a novel coronavirus and a novel challenge for critical care [published correction appears in *Intensive Care Med.* 2020;46(5):1087–1088]. *Intensive Care Med.* 2020;46(5):833–836.
- Huo X, Chen LL, Hong L, et al. Economic burden and its associated factors of hospitalized patients infected with A (H7N9) virus: a retrospective study in Eastern China, 2013–2014. *Infect Dis Pover.* 2016;5(1):79.
- Rootman I, Goodstadt M, Hyndman B, et al. Evaluation in Health Promotion: Principles and Perspectives: WHO Regional Office Europe. <https://www.euro.who.int/en/publications/abstracts/evaluation-in-health-promotion-principles-and-perspectives>. Published 2001. Accessed November 25, 2020.
- Bartsch SM, Ferguson MC, McKinnell JA, et al. The potential health care costs and resource use associated with COVID-19 in the United States. *Health Aff (Millwood).* 2020;39(6):927–935.
- Lee GM, Lett S, Schauer S, et al. Societal costs and morbidity of pertussis in adolescents and adults. *Clin Infect Dis.* 2004;39(11):1572–1580.
- Xiao F, Chen BW, Wu YF, Wang YX, Han DM. Beijing (Provisional) Commanding Center For SARS Treatment and Cure Scientific Research Group. [Analysis on the cost and its related factors of clinically confirmed severe acute respiratory syndrome cases in Beijing]. *Zhonghua Liu Xing Bing Xue Za Zhi Zhonghua Liuxingbingxue Zazhi.* 2004;25(4):312–316.
- Fellowship in the diagnosis and treatment of COVID 19 disease at outpatient and inpatient levels Ministry of Health and Medical Education of Iran. MOHME. <https://v-darman.mums.ac.ir/images/v-darman/corona2019/Darman/Darman-Corona-35.pdf>. Published 2020. Accessed November 25, 2020.
- Zhou L, Situ S, Huang T, et al. Direct medical cost of influenza-related hospitalizations among severe acute respiratory infections cases in three provinces in China. *PLoS One.* 2013;8(5), e63788.