



In-hospital Economic Burden for COVID-19 Infection Using Step-Down Cost Accounting: A Case from Central Iran

Hadi Hamidi Parsa¹, Abedin Saghafipour^{2,*}, Alireza Koohpaei³, Babak Farzinnia⁴ and Mohsen Barouni⁵

¹Deputy of Management and Resources Development, Qom University of Medical Sciences, Qom, Iran

²Department of Public Health, Faculty of Health, Qom University of Medical Sciences, Qom, Iran

³Department of Occupational Health & Safety, Faculty of Health, Qom University of Medical Sciences, Qom, Iran

⁴Department of Environmental Health Engineering, Faculty of Health, Qom University of Medical Sciences, Qom, Iran

⁵Health Services Management Research Center, Institute for Futures Studies in Health, Kerman University of Medical Sciences, Kerman, Iran

*Corresponding author: Department of Public Health, Faculty of Health, Qom University of Medical Sciences, Qom, Iran. Email: abed.saghafi@yahoo.com

Received 2021 March 08; Revised 2021 July 25; Accepted 2021 September 13.

Abstract

Background: The novel coronavirus disease 2019 (COVID-19) has placed heavy direct and indirect economic burden on the people and the health system.

Objectives: The present study aimed to estimate the economic burden of COVID-19 in Qom Province, using the step-down cost accounting (SDCA) method.

Methods: This descriptive, cross-sectional study included all COVID-19 patients in Qom Province from February 19, 2020, to June 19, 2020. The patients' data were collected in the form of major cost groups with integrated health system (IHS), health information system (HIS), and a financial software called Roozamad. The governmental, out-of-pocket, and opportunity costs paid by patients and hospitals were calculated and evaluated using SDCA in Microsoft Excel software.

Results: The incidence of COVID-19 infection was 518 per 100,000 populations in Qom Province in the aforementioned period. The total government costs for the treatment of the patients were calculated to be 2,229,216,930,370 Rials (8,916,867 \$). Among the major governmental cost groups, personnel costs accounted for the highest total expenditures. In addition, out-of-pocket costs of patients and their families equaled 30,038,013,060 Rials (120,152 \$). The costs of final service departments accounted for more than half of the total costs. The opportunity costs were calculated as 420 billion Rials (15.68% of total costs).

Conclusions: According to the findings, the direct and indirect costs associated with the treatment of COVID-19 patients can impose a heavy economic burden on the households and health care system. Therefore, disease prevention strategies such as observing health protocols are recommended to reduce the burden of the disease.

Keywords: COVID-19 Infection, Economic Burden, Step-Down Cost Accounting, Iran

1. Background

Acute respiratory infections (ARIs) lead to the illness, death, and hospitalization of millions of people around the world annually and can impose a heavy socioeconomic burden on communities (1). In Iran, ARIs have caused several disease outbreaks every year and made a large number of the country's population to be hospitalized (2). Currently, the novel coronavirus, severe acute respiratory syndrome Coronavirus 2 (SARS-CoV-2), has caused acute respiratory infections called Coronavirus disease 2019 (COVID-19) in Iran and the world. The coronaviruses are important pathogens in humans and animals (3). In late 2019, a novel coronavirus was identified as causing a group of pneumonia cases in Wuhan City, Hubei Province, China (4).

The novel coronavirus spread rapidly in China and around the world (5). On March 11, 2020, the World Health Organization (WHO) declared a COVID-19 pandemic outbreak (6). According to the WHO report, as of October 18 2020, there have been 39,596,858 confirmed cases of COVID-19, including 1,107,374 deaths (7). The novel coronavirus has imposed a great direct and indirect economic burden on the people and the health system. During the COVID-19 pandemic, the costs, including definitive diagnosis, intensive and general care beds, medicines and medical consumables, income loss due to premature death, economic production loss due to hospitalization, and job absenteeism have been added to the household budget and health system (8). The disease has also imposed heavy costs on the health system, most of which are the costs of bed days, including accom-

modation, food, and necessary care. In addition, the direct costs of COVID-19 in the health system comprise the provision of personal protective equipment for health care personnel, the supply of patients' medicines, the provision of diagnostic kits, laboratory and radiology services, hospitalization and intensive care, the provision of the convalescent home and also the supply of items needed by hospitals (9). In recent years, determining the cost to achieve a clear picture of the cost trend and formulating the operating budget and effective use of resources have been considered from the perspective of health economics. Cost analysis as a management tool can help us provide the right data for making more informed investment decisions about actions and infrastructures (10). Although COVID-19 has affected all social, cultural, and political aspects of societies, its economic effects are mainly due to the implementation of social distancing and business closure plans as well as the reduction of the number of workers working in production centers more than other sections (11). In a cost-of-illness study, in January - March 2020, the economic burden of COVID-19 was estimated to be 0.62 US\$ in China (12). In addition, it has been estimated that COVID-19 has caused financial impact of an average of 50.7 \$ billion per month in lost income for America's healthcare systems (13). There are several methods to determine the economic burden of diseases (10). The SDCA method is one of the modern methods that divides the costs into three categories (overhead, intermediate, and final costs) and separates the cost groups in each section into a suitable form for separating and recording the cost so that all costs in the overhead start with the intermediate and final wards with the costs of the intermediate wards then being divided into the final wards. Thus, the hospitals costs with any number of products can be calculated accurately and appropriately (14). In line with the prevalence of COVID-19 pandemic in the world and Iran, Qom Province was one of the provinces heavily affected by the disease (15).

2. Objectives

This study aimed to estimate the economic burden of COVID-19 infection in Qom Province, Central Iran, the SDCA method.

3. Methods

3.1. Data Collection

This descriptive, cross-sectional study was conducted on all COVID-19 patients (1,959 patients) in Qom Province over the time period from February 19, 2020, to June 19, 2020 with the first peak of the disease. The patients' data

were collected in the form of major cost groups (personnel costs, medicine, and medical supplies costs, administrative, health and treatment facilities costs, urban amenities costs, and building depreciation and physical spaces costs) registered in the integrated health system (IHS) that is a registration system of hospitalized patients together with the data accumulated by a piece of financial and accounting software called Roozamad, which is an accrual accounting system capable of extracting operating costs for goods or services (available at: Jobs@Azarakhsh.ws) used in Iranian Universities of Medical Sciences.

3.2. Ethical Considerations

Ethical approval was obtained from the Institutional Ethics Committee of Qom University of Medical Sciences (Qom, Iran) ([IR.MUQ.REC.1399.128](https://doi.org/10.21860/IR.MUQ.REC.1399.128)).

3.3. Statistical Analysis

The major cost groups were divided into overhead, intermediate and final service departments. The data were collected in pre-designed tables, entered into Excel software and analyzed using SDCA in seven steps: (1) step 1, defining the final product included in this study for the treatment of COVID-19 patients who were referred to hospitals or hospitalized; (2) step 2: defining cost centers by identifying all service provider units and wards and subclassifying them into three separate departments based on the SDCA method [Overhead Service Department; providing overhead support services to the intermediate and final service departments, Intermediate Service Department; providing support services to patient care units and organizing as separate, independent units and Final Service Department providing direct services to patients ([Table 1](#))]; (3) step 3, identifying the full costs of each input (in this study major cost groups were considered); (4) step 4, assigning inputs to cost centers ([Table 2](#)); (5) step 5, allocating all costs to final cost centers; (6) step 6, computing total and unit costs for each final cost center; (7) step 7, reporting the results ([14](#)). Thus, the governmental, out-of-pocket, and opportunity costs paid by patients and hospitals in Qom Province in the specified time period (February 19 to June 19, 2020) were evaluated to calculate the economic burden using SDCA in Microsoft Excel 2010 software.

In [Table 2](#), to identify the criteria and calculate them, different criteria are adopted to allocate overhead and intermediate costs to the final center. A portion of overhead costs was first allocated to the intermediate and then to the final center, and another portion was directly allocated to the final center. If the metrics of the performance of overhead and intermediate activities were quantifiable, such as radiology films and the number of cooked foods, the metrics of overhead sector were directly calculated from HIS and the university's performance accounting software,

Table 1. Classification of Service Provider Units and Wards Based on Overhead, Intermediate and Final Costs Associated with COVID-19 Cases in Qom Province, Central Iran

Overhead Service Departments	Intermediate Service Departments	Final Service Departments
The headquarters of University of Medical Sciences	Emergency Departments	Internal medicine
Main office of provincial health center	Urban texture and suburban health posts	Intensive care units (ICU)
Head of hospital wards	Comprehensive health centers	Pre-hospital emergency medical service
Management of hospital wards	Pharmacy	-
Administrative affairs	Radiology	-
Financial affairs	Laboratory	-
Budget office	kitchen	-
Service office	Laundry	-
Facilities office	Other diagnostic centers	-
Vehicle office	-	-
Guard office	-	-
Hospitals warehouse	-	-
Admission	-	-
Discharge	-	-
Medical records department	-	-
Main office of food & drug administration	-	-
Main office of emergency	-	-
Others	-	-

and the Rial-based performance was allocated to the final center. Moreover, issues related to management, chairmanship, etc. were determined by interviews, work assessment, and the analysis of conducted performances regarding COVID-19 management, treatment, and prevention. Afterward, their costs were calculated out of the overall direct costs and were directly allocated to the final center or, if related to the intermediate center, were first allocated to the intermediate center and then to the final center.

In addition, in another section of the study, the opportunity costs were also calculated in the study period. The opportunity costs equal the income that has been lost due to the change of income-generating beds to the new coronavirus diseases beds in Qom University of Medical Sciences in the study period. The change of income-generating beds mainly included the limited surgical, orthopedic, cardiac wards of hospitals (16). To have an international currency base, each dollar was considered equal to 250,000 Rials at the time of data collection in Iran.

4. Results

The incidence of COVID-19 infection was 518 per 100,000 populations in Qom Province from February 19, 2020 to June 19, 2020 (6,696 cases/1,292,283 populations). Also, 29.25% of the patients were hospitalized (1,959/6,696).

The total government costs for the treatment of patients with COVID-19 in the hospitals of Qom Province in this period were calculated to be 2,229,216,930,370 Rials (8,916,867 \$) (Table 3). Among the major governmental cost groups, personnel and urban amenities accounted for the highest and lowest of total expenditures, respectively (Table 4). In addition, the results indicated that the out-of-pocket costs of patients and their families were 30,038,013,060 Rials (Table 5). Based on the SDCA method, the costs of the final service department, including internal medicine, ICU, and pre-hospital emergency medical service wards dealing with COVID-19 patients, accounted for more than 56% of the total cost (Table 4).

In this study, the opportunity costs were found to equal 420 billion Rials (15.68% of total costs) for COVID-19 patients in the hospitals (Table 5).

The total amount of governmental, opportunity, and out-of-pocket costs associated with patients hospitalized COVID-19 patients in Qom Province were found to be 2,679,254,943,430 Rials (Table 5). Besides, the total expenditure per capita of a patient with COVID-19 hospitalized for the government and the patients' families was estimated as 1,367,664,596 Rials (5,470.65\$) (Table 6).

Finally, the costs per capita groups, including the mean cost per inpatient case, mean cost per case, and provincial per capita costs, were also evaluated (Table 7).

Table 2. The Criteria for Allocating Inputs to Cost Centers (Overhead and Intermediate) for the Treatment of Patients with COVID-19 in the Hospitals

Cost Centers	The Criteria For Allocating Inputs
Overhead Service Departments	
The headquarters of University of Medical Sciences	Portion of each center of the direct costs
Main office of Provincial Health center	Portion of each center of the direct costs
Head of Hospital Wards	Portion of each center of the direct costs
Management of Hospital Wards	Portion of each center of the direct costs
Administrative Affairs	Portion of each center of the direct costs
Financial Affairs	Portion of each center of the direct costs
Budget Office	Portion of each center of the direct costs
Service Office	Area/(m ²)
Facilities Office	Area/(m ²)
Vehicle Office	Number of staffs
Guard Office	Portion of each center of the direct costs
Hospitals warehouse	Portion of each center of the direct costs
Admission	Portion of each center of the direct costs
Discharge	Portion of each center of the direct costs
Medical Records Department	Portion of each center of the direct costs
Intermediate service departments	
Main office of food & drug administration	Portion of each center of the direct costs
Main office of emergency	Portion of each center of the direct costs
Others	Portion of each center of the direct costs
Emergency Departments	Number of missions
Urban texture and suburban health posts	Number of clients
Comprehensive health centers	Number of clients
Pharmacy	Portion of each section in the prescriptions
Radiology	Number of admissions
Laboratory	Number of admissions
Kitchen	Number of patients and staffs
Laundry	Number of patients
Other diagnostic centers	Number of patients

Table 3. Major Cost Groups of Governmental Costs Associated with COVID-19 Cases in Qom Province, Central Iran, from February 19, 2020, to June 19, 2020

Major Cost Groups	Total Cost; Rials (\$) ^a	% Out of Total Costs
Personnel costs	1,470,783,420,482 (5,883,133.68)	65.97
The cost of medicine and medical supplies	297,813,684,888 (1,191,254.73)	13.36
Administrative, health and treatment facilities costs	312,112,985,000 (1,248,451.94)	14.00
Urban amenities costs	28,218,450,000 (112,873.8)	1.27
Building depreciation and physical spaces costs	120,288,570,000 (481,154.28)	5.40
Total	2,229,216,930,370 (8,916,867)	100

^a One dollar = 250,000 Rials.

Table 4. Major Cost Groups of Governmental Costs Associated with COVID-19 Cases Based on Cost Departments in Qom Province, Central Iran, from February 19, 2020, to June 19, 2020

Cost Departments	Major Cost Groups; Rials (\$) ^a					Total [%]
	Personnel	Medicine and Medical Supplies	Administrative, Health, and Treatment Facilities	Urban Amenities	Building Depreciation and Physical Spaces	
Overhead service	235,617,513,073 (942,470)	48,056,605,044 (192,226)	87,391,635,800 (349566)	8,747,580,000 (34,990)	34,601,869,800 (138,407)	414,415,203,717 (1,657,660.81) [19]
Intermediate service	371,695,855,121 (1,486,783)	77,466,983,199 (309,868)	74,907,116,400 (299,628)	7,336,680,000 (29,347)	26,745,580,200 (106,982)	558,152,214,920 (2,232,608.86) [25]
Final service	863,470,052,288 (3,453,880)	172,290,096,645 (689,160)	149,814,232,800 (599,257)	12,134,010,000 (48,536)	58,941,120,000 (235764)	1,256,649,511,733 (5,026,598) [56]
Total costs [%]	1,470,783,420,482 (5,883,134)	297,813,684,888 (1,191,255)	312,112,985,000 (1,248,452)	28,218,270,000 (112,873)	120,288,570,000 (481154)	2,229,216,930,370 (8,916,867)[100]

^a One dollar = 250,000 Rials.**Table 5.** The Total Costs Associated with COVID-19 Cases in Qom Province, Central Iran, from February 19, 2020 to June 19, 2020

Cost Groups	Costs; Rials (\$) ^a	% of Total Costs
Governmental	2,229,216,930,370 (8,916,867)	83.20
Opportunity	420,000,000,000 (1,680,000)	15.68
Out of pocket	30,038,013,060 (120,152)	1.12
Total	2,679,254,943,430 (10,717,019)	100

^a One dollar = 250,000 Rials.**Table 6.** The Total Costs Associated with Patients Hospitalized with COVID-19 in Qom Province, Central Iran, from February 19, 2020 to June 19, 2020

Major Costs Groups	Treatment Care Costs		
	Total Costs of Cases; Rials (\$) ^a	% Out of Total Costs	Expenditure per Capita; Rials (\$) ^a
Governmental costs	2,649,216,930,370 (10,596,867)	98.88	1,352,331,256 (5,409.32)
Out of pocket	30,038,013,060 (120,152)	1.12	15,333,340 (61.34)
Total costs	2,679,254,943,430 (10,717,019)	100	1,367,664,596 (5,470.65)

^a One dollar = 250,000 Rials.**Table 7.** The per Capita Total Costs Associated with COVID-19 Patients in Qom Province, Central Iran, from February 19, 2020, to June 19, 2020

Costs per Capita Groups	Costs Rials (\$) ^a
Mean cost per inpatient case	1,367,664,596 (5,470.65)
Mean cost per case	395,641,716 (1,582.56)
Provincial per capita costs	2,050,029 (8.20)

^a One dollar = 250,000 Rials.

5. Discussion

It seems that research on the economic consequences of a disease imposed on patients, families, and society is inevitable. Conducting scientific research in this field is a great help to health policymakers in preventing, treating, and controlling diseases. Recently, in the case of COVID-19 disease, Qom Province in central Iran has been one of the

red provinces (17-19). The COVID-19 pandemic has exerted many adverse effects on various aspects of health, economy, and social life in the world, but what is certain is that in addition to human deaths, the disease has also placed a great economic burden on governments and people (20). The total government costs for treating COVID-19 patients in Qom Province hospitals in this period have been calculated to be 8,916,867 \$, more than 83% of total costs. In addition, the results of the present study show that nearly 66% of total government costs were consumed as personnel costs for paying salaries. Previous studies have also revealed that the largest portion of the burden of the disease is related to personnel costs. For instance, the personnel expenditure in hospitals in Ghana was evaluated to be 40 - 60% of total costs (21). In the intensive care unit of a hospital in Germany, 42% of total costs belonged to salary payments to the personnel (22). In general, research demon-

strates that personnel costs cover almost 60% of total direct costs (23).

Besides, in the majority of studies aiming to estimate the economic burden of diseases in different hospital wards, the costs of medical materials and devices are higher than other major groups of governmental costs (21, 22). Yet, accordingly, the financings of this study regarding the COVID-19 pandemic, to provide better services to patients, personnel from many other hospital wards and health centers were added to the wards of coronavirus patients, leading to an increase in personnel costs in this ward. It also seems necessary to provide more financial support to the personnel of COVID-19 wards to increase their motivation, so high personnel costs in the COVID -19 care wards are expected. Based on the SDCA method, the costs of final service department, including internal medicine, ICU, and pre-hospital emergency medical service wards involved with treating COVID-19 cases accounted for more than half the total costs. The findings of similar studies also indicate that the costs of the final service department are higher than the overhead and intermediate service department costs in hospitals (23, 24). However, in an epidemic situation, the costs of the final ward usually increase as the number of patients admitted to the internal medicine, ICU, and pre-hospital emergency medical wards increases. In the case of the COVID-19 pandemic, the increase in the number of patients referred to hospitals has raised the costs of the final ward. It seems that the observance of health measures, such as social distancing, regular hand washing, wearing masks and gloves, disinfecting fruits and vegetables, disinfecting surfaces, and personal hygiene, has reduced the incidence of the disease and the number of hospitalizations (25). Hence, we can conclude that by reducing the number of referrals to the internal medicine, ICU, and pre-hospital emergency medical wards, the costs incurred by hospitals in the final department are reduced.

It was found in this study that the opportunity costs for COVID-19 patients in the hospitals reached 420 billion Rials (15.68% of total costs). It is equal to the income that has been lost due to the change of income-generating beds to the new coronavirus diseases beds in Qom University of Medical Sciences in the study period. Changing income-generating beds (mainly including the limited surgical, orthopedic, and cardiac wards of hospitals) into COVID-19 patients' beds has drastically reduced the special incomes of the hospitals. Some previous studies evaluated the opportunity costs of using hospital beds (26, 27). Nevertheless, its impact on the hospital budget is important and should be considered. Moreover, the results of this study revealed that out-of-pocket costs of patients and their families equaled 30,038,013,060 Rials. In addition to opportunity costs, large sums of patients' income (out-of-pocket)

were also spent on COVID-19 disease in the study period. Such costs incurred by patients and their families can adversely affect other aspects of their lives.

The important issue in this study is that the economic burden of the disease has been much higher than the calculated figure, and to calculate it, with the cooperation of the Ministry of Industry, Mine and Trade, as well as the governor's office and other related agencies, damaged jobs and other social losses to be recorded. In this study, only treatment and health costs, opportunity costs related to the lost income of the Qom Province hospitals, and out-of-pocket costs of inpatients were calculated. Besides, the main limitation of the study was that the included cases did not cover all COVID-19 cases in Qom Province; nevertheless, the results seem to partly indicate total costs spent on health care services provided to COVID-19 patients in this area.

5.1. Conclusions

According to the findings, the direct and indirect costs of the treatment of COVID-19 patients can place a heavy economic burden on patients and health systems, including damaged jobs and other social losses, the opportunity costs related to the income loss in Qom Province hospitals, and out-of-pocket costs of inpatients on households and the health care system. Therefore, disease prevention strategies such as observing health protocols are recommended to reduce the economic burden of the disease.

Acknowledgments

The authors are grateful to the research deputy of Qom University of Medical Science.

Footnotes

Authors' Contribution: Saghafipour A. and Hamidi Parsa H., conceived and co-designed the study; Saghafipour A., Hamidi Parsa H., and Koohpaei AR., analyzed and interpreted the data; Saghafipour A., Hamidi Parsa H., Koohpaei AR., and Farzinnia B., contributed to the preparation of reagents, materials, and analysis tools or data; Saghafipour A. and Hamidi Parsa H., collected the primary data. All of the authors contributed to writing the manuscript.

Conflict of Interests: There are no financial conflicts of interest to disclose.

Ethical Approval: Ethical approval was obtained from the Institutional Ethics Committee of Qom University of Medical Sciences (Qom, Iran) (IR.MUQ.REC.1399.128).

Funding/Support: Funding for this research was provided by the Research and Technology Center of Qom University of Medical Sciences.

Informed Consent: Owing to the fact that in this study, we did not visit the patients and only the data related to the patients were obtained from the finance section of the University, so the informed consent of the patients was not required.

References

- Tomczyk S, McCracken JP, Contreras CL, Lopez MR, Bernart C, Moir JC, et al. Factors associated with fatal cases of acute respiratory infection (ARI) among hospitalized patients in Guatemala. *BMC Public Health*. 2019;**19**(1):499. [PubMed ID: 31053069]. [PubMed Central ID: PMC6498661]. <https://doi.org/10.1186/s12889-019-6824-z>.
- Naghipour M, Hart CA, Cuevas LE. Burden of acute respiratory infections in a family cohort in Iran. *Epidemiol Infect*. 2007;**135**(8):1384–8. [PubMed ID: 17313695]. [PubMed Central ID: PMC2870706]. <https://doi.org/10.1017/S0950268807008114>.
- Mohammadzadeh Rostami F, Nasr Esfahani B, Ahadi AM, Shalibeik S. A review of novel Coronavirus, severe acute respiratory syndrome Coronavirus 2 (SARS-CoV-2). *Iran J Med Microbiol*. 2020;**14**(2):154–61. <https://doi.org/10.30699/ijmm.14.2.154>.
- Zhu N, Zhang D, Wang W, Li X, Yang B, Song J, et al. A novel Coronavirus from patients with pneumonia in China, 2019. *N Engl J Med*. 2020;**382**(8):727–33. [PubMed ID: 31978945]. [PubMed Central ID: PMC7092803]. <https://doi.org/10.1056/NEJMoa2001017>.
- Kamel Boulos MN, Geraghty EM. Geographical tracking and mapping of Coronavirus disease COVID-19/severe acute respiratory syndrome Coronavirus 2 (SARS-CoV-2) epidemic and associated events around the world: How 21st century GIS technologies are supporting the global fight against outbreaks and epidemics. *Int J Health Geogr*. 2020;**19**(1):8. [PubMed ID: 32160889]. [PubMed Central ID: PMC7065369]. <https://doi.org/10.1186/s12942-020-00202-8>.
- World Health Organization. *Naming the Coronavirus disease (COVID-19) and the virus that causes it*. Geneva, Switzerland: World Health Organization; 2020. Available from: [https://www.who.int/emergencies/diseases/novel-coronavirus-2019/technical-guidance/naming-the-coronavirus-disease-\(covid-2019\)-and-the-virus-that-causes-it](https://www.who.int/emergencies/diseases/novel-coronavirus-2019/technical-guidance/naming-the-coronavirus-disease-(covid-2019)-and-the-virus-that-causes-it).
- World Health Organization. *WHO Coronavirus disease (COVID-19) dashboard*. World Health Organization: Geneva, Switzerland; 2020, [updated 15th Oct 2021; cited 18th Oct 2020]. Available from: <https://covid19.who.int/>.
- Ghaffari Darab M, Keshavarz K, Sadeghi E, Shahmohamadi J, Kavosi Z. The economic burden of Coronavirus disease 2019 (COVID-19): Evidence from Iran. *BMC Health Serv Res*. 2021;**21**(1):132. [PubMed ID: 33573650]. [PubMed Central ID: PMC7877330]. <https://doi.org/10.1186/s12913-021-06126-8>.
- World Health Organization. *Shortage of personal protective equipment endangering health workers worldwide*. Geneva, Switzerland: World Health Organization; 2020. Available from: <https://www.who.int/news/item/03-03-2020-shortage-of-personal-protective-equipment-endangering-health-workers-worldwide>.
- Cylus J, Papanicolas I, Smith PC. *Health system efficiency: How to make measurement matter for policy and management*. Copenhagen (Denmark): European Observatory on Health Systems and Policies; 2016.
- He H, Harris L. The impact of Covid-19 pandemic on corporate social responsibility and marketing philosophy. *J Bus Res*. 2020;**116**:176–82. [PubMed ID: 32457556]. [PubMed Central ID: PMC7241379]. <https://doi.org/10.1016/j.jbusres.2020.05.030>.
- Jin H, Wang H, Li X, Zheng W, Ye S, Zhang S, et al. Economic burden of COVID-19, China, January–March, 2020: A cost-of-illness study. *Bull World Health Organ*. 2021;**99**(2):112–24. [PubMed ID: 33551505]. [PubMed Central ID: PMC7856360]. <https://doi.org/10.2471/BLT.20.267112>.
- Kaye AD, Okeagu CN, Pham AD, Silva RA, Hurley JJ, Arron BL, et al. Economic impact of COVID-19 pandemic on healthcare facilities and systems: International perspectives. *Best Pract Res Clin Anaesthesiol*. 2021;**35**(3):293–306. [PubMed ID: 34511220]. [PubMed Central ID: PMC7670225]. <https://doi.org/10.1016/j.bpa.2020.11.009>.
- Conteh L, Walker D. Cost and unit cost calculations using step-down accounting. *Health Policy Plan*. 2004;**19**(2):127–35. [PubMed ID: 14982891]. <https://doi.org/10.1093/heapol/czh015>.
- Ghadir MR, Ebrazeh A, Khodadadi J, Zamanlu M, Shams S, Nasiri M, et al. The COVID-19 outbreak in Iran; the first patient with a definite diagnosis. *Arch Iran Med*. 2020;**23**(7):503–4. [PubMed ID: 32657602]. <https://doi.org/10.34172/aim.2020.48>.
- Sandmann FG, Robotham JV, Deeny SR, Edmunds WJ, Jit M. Estimating the opportunity costs of bed-days. *Health Econ*. 2018;**27**(3):592–605. [PubMed ID: 29105894]. [PubMed Central ID: PMC5900745]. <https://doi.org/10.1002/hec.3613>.
- Ahmadi M, Sharifi A, Khalili S. Presentation of a developed sub-epidemic model for estimation of the COVID-19 pandemic and assessment of travel-related risks in Iran. *Environ Sci Pollut Res Int*. 2021;**28**(12):14521–9. [PubMed ID: 33215282]. [PubMed Central ID: PMC7676861]. <https://doi.org/10.1007/s11356-020-11644-9>.
- Saghafipour A. Indirect and Potential Impacts of the COVID-19 Pandemic on the Public Health. *J Res Health Sci*. 2020;**20**(3):e00492. [PubMed ID: 33169724]. [PubMed Central ID: PMC7585763]. <https://doi.org/10.34172/jrhs.2020.25>.
- Ramirez-Aldana R, Gomez-Verjan JC, Bello-Chavolla OY. Spatial analysis of COVID-19 spread in Iran: Insights into geographical and structural transmission determinants at a province level. *PLoS Negl Trop Dis*. 2020;**14**(11):e0008875. [PubMed ID: 33206644]. [PubMed Central ID: PMC7710062]. <https://doi.org/10.1371/journal.pntd.0008875>.
- Qiu Y, Chen X, Shi W. Impacts of social and economic factors on the transmission of Coronavirus disease 2019 (COVID-19) in China. *J Popul Econ*. 2020:1–46. [PubMed ID: 32395017]. [PubMed Central ID: PMC7210464]. <https://doi.org/10.1007/s00148-020-00778-2>.
- Aboagye AQ, Degboe AN, Obuobi AA. Estimating the cost of healthcare delivery in three hospitals in southern Ghana. *Ghana Med J*. 2010;**44**(3):83–92. [PubMed ID: 21327011]. [PubMed Central ID: PMC2996840]. <https://doi.org/10.4314/gmj.v44i3.68890>.
- Goeree R, Gafni A, Hannah M, Myhr T, Blackhouse G. Hospital selection for unit cost estimates in multicentre economic evaluations. Does the choice of hospitals make a difference? *Pharmacoeconomics*. 1999;**15**(6):561–72. [PubMed ID: 10538329]. <https://doi.org/10.2165/00019053-199915060-00004>.
- Shepard DS, Hodgkin D, Yvann AE, Paydar A, translator. *[Analysis of hospital costs: A manual for managers]*. Tehran, Iran: Tehran Sogand Publication Co; 2001. Persian.
- Salimi M, Saghafipour A, Hamidi Parsa H, Khosravi M. Economic burden associated with head louse (*Pediculus humanus capitis*) infestation in Iran. *Iran J Public Health*. 2020;**49**(7):1348–54. [PubMed ID: 33083302]. [PubMed Central ID: PMC7548503]. <https://doi.org/10.18502/ijph.v49i7.3589>.
- Salimi M, Saghafipour A, Hamidi Parsa H, Khosravi M, Shirzadi MR. Economic burden evaluation of cutaneous leishmaniasis in Iran. *Shiraz E-Med J*. 2019;**20**(6):e82810. <https://doi.org/10.5812/semj.82810>.
- Hadian M, Mohammadzade A, Imani A, Golestani M. [Analysis and unit cost estimation of services using “step-down method” in Fatemeh hospital of Semnan university of medical sciences-2006 Iran]. *J Health Adm*. 2009;**12**(37):39–48. Persian.
- Noori M, Markazi Moghaddam N, Goudarzi R, Meshkani Z. Surveying activity based costing of final units (a case study in one of the armed forces hospitals). *Hospital*. 2016;**15**(1 (56)):41–50.