Original Article

Healthcare Resource Utilization and Healthcare Costs of COVID-19 Patients in A Tertiary Care Public Hospital: A Retrospective Cohort Study in Thailand

Jirapong Leeyaphan MD[1], Charussri Leeyaphan MD[2], Patama Suttha MD[1], Suthira Taychakhoonavudh PhD[3], Nattanichcha Kulthanachairojana PhD[4]

[1] Bamrasnaradura Infectious Diseases Institute, Department of Disease Control, Ministry of Public Health, Nonthaburi, Thailand

[2] Department of Dermatology, Faculty of Medicine Siriraj Hospital, Mahidol University, Bangkok, Thailand

[3] Department of Social and Administrative Pharmacy, Faculty of Pharmaceutical Sciences, Chulalongkorn University, Bangkok, Thailand

[4] Division of Social and Administrative Pharmacy, Faculty of Pharmaceutical Sciences, Burapha University, Chonburi, Thailand

Objective: Health care costs (HCCs) are a significant concern in developing countries. The authors investigated the healthcare resource utilization (HCRU) and HCCs for patients with COVID-19 based on disease severity and infection site.

Materials and Methods: The authors reviewed data from the electronic medical records of COVID-19 patients admitted to the present study hospital between January 2020 and April 2020. The authors used comorbidities and patient characteristics as covariates. Analyses were conducted using simple linear regression and generalized linear regression models with a log-link and gamma distribution.

Results: Two hundred two patients had confirmed SARS-CoV-2 infection. Total costs per patient were 6,626 USD (756 to 45,586). Personal protection equipment costs were the most significant cost for COVID-19 patients with a mean of 3,778 USD. The mean treatment cost per patient was 326 USD. Patients with severe symptoms and lower respiratory tract infection (LRI) had a higher cost and resource utilization value before and after adjusting for covariates.

Conclusion: COVID-19 patients with severe symptoms and LRI had higher HCRU. Length of stay, severity of symptoms, and LRI were associated with higher cost of treatment.

Keywords: SARS-CoV-2; COVID-19; Healthcare resource utilization; Healthcare costs; Thailand

Received 21 June 2021 | Revised 17 November 2021 | Accepted 23 November 2021

J Med Assoc Thai 2021;104(12):1953-8

Website: http://www.jmatonline.com

The Coronavirus outbreak began in China in late December 2019[1]. In Thailand, the Bamrasnaradura Infectious Diseases Institute, a referral-based public hospital responsible for emerging disease control, managed patients infected with the SARS-CoV-2 virus. The disease caused by SARS-CoV-2 was later named COVID-19 by the World Health Organization (WHO). The mortality rate of COVID-19 ranged from 1% to 12% in China[2], 8% in Iran[3], 39% in the United States of America (USA)[4], and 2% in Thailand[5].

Health care costs (HCCs) are the significant concern in developing countries. Therefore, the development of treatment cost models will help creating effective health policies. For example, a novel avian-origin influenza A (H7N9) virus infection transmitted via the respiratory tract had a treatment cost model graded by disease severity. From the model for H7N9 infection in China, the mean cost was 1,619 USD for mildly ill patients, 22,292 USD for severe cases without death, and 32,956 USD for severe cases with death[6]. Regarding the direct costs of hospitalization, the medication costs were the most significant contributors to HCCs, and the total fees correlated with disease severity[7]. Additionally, from the model for severe acute respiratory syndrome (SARS), length of hospitalization, disease severity, stage of the disease outbreak, patient's occupation, baseline disease status, and medical insurance status also affected the medical costs of confirmed cases[8].

Concerning COVID-19, a simulation model

Correspondence to:

Kulthanachairojana N.

Faculty of Pharmaceutical Sciences, Burapha University, 169 Longhadbangsaen Road, Sansuk District, Chonburi 10130, Thailand.

Phone: +66-82-6963561

Email: nattanichcha@go.buu.ac.th

How to cite this article:

Leeyaphan J, Leeyaphan C, Suttha P, Taychakhoonavudh S, Kulthanachairojana N. Healthcare Resource Utilization and Healthcare Costs of COVID-19 Patients in A Tertiary Care Public Hospital: A Retrospective Cohort Study in Thailand. J Med Assoc Thai 2021;104:1953-8.

doi.org/10.35755/jmedassocthai.2021.12.13109

from the USA demonstrated that one symptomatic case could result in a median direct medical cost of 3,045 USD[9]. However, no study has so far reported the direct medical costs of COVID-19 cases in a developing country, which included the treatment model. Therefore, the authors investigated healthcare resource utilization (HCRU) and HCCs for patients with COVID-19 based on disease severity and infection site in the present retrospective study.

Materials and Methods

Study population

The authors reviewed the electronic medical records of patients admitted to the Bamrasnaradura Infectious Diseases Institute between January 2020 and April 2020. All patients had at least one positive SARS-CoV-2 test using real-time polymerase chain reaction (RT-PCR). The treatments were independently prescribed by hospital physicians. The hospital discharge criteria included both clinical improvement and a negative RT-PCR.

Data collection

The authors collected demographic data, including age, gender, and nationality, and data on underlying diseases. In addition, COVID-19 related data were collected, including duration of hospitalization, disease onset, and severity. The study protocol was approved by the Bamrasnaradura Infectious Diseases Institute Institutional Review Board (S010h/63_ExPD). All procedures performed in the present study were in accordance with the 1964 Helsinki declaration.

Healthcare costs and healthcare resources utilization

HCCs and HCRU of hospitalized COVID-19 patients were categorized into six groups, 1) room, 2) personal protective equipment (PPE), 3) treatment, 4) investigation, 5) surgery and nursing care, and 6) cleansing. The authors calculated the HCRU and HCCs for all patients. HCRU included medication, intravenous fluid, home medication, medical device costs, blood and blood components, and alternative medicine costs. The diagnostic investigations included radiologic examinations, special investigations, ultrasonography, computed tomography, digital imaging, and pathological examinations. Surgery and nursing care included surgical devices, operative procedures, nursing care, dental care, and rehabilitation. HCCs were determined using the allowable amount remitted to providers on claims. HCCs included medication, oxygen therapy, blood transfusion, X-ray investigation, special investigation, medical devices, and procedures. The cost was converted from Thai Baht to USD using the exchange rate: 31.03 Baht to 1 USD, which was the exchange rate for June 1, 2020.

Disease severity and respiratory site infection

Patients with COVID-19 were grouped according to their severity of disease. Cases that had one of the following criteria were defined as having severe infection, 1) leafy lesions or lesion progress greater than 50% in 48 hours, indicated by chest radiograph, 2) dyspnea, respiratory rate greater than 24 per minute, 3) severe hypoxemia, patients' SpO_2 of 92% or less under oxygen flow of three to five liters per minute, or 4) shock, acute respiratory distress syndrome, or multiple organ dysfunction syndrome[7]. Patients that did not fit these criteria were defined as mild cases. For the respiratory infection sites, diagnoses such as the common cold, acute tracheobronchitis, and acute pharyngitis were considered upper respiratory tract infections (URI), whereas pneumonia was considered a lower respiratory tract infection (LRI).

Statistical analysis

Descriptive statistics were generated to evaluate the demographic and clinical characteristics by disease severity and infection site. Simple linear regression models were used for the analyses of HCRU and HCC outcomes. A generalized linear regression model with a log-link and gamma distribution was used for the analysis of HCCs. A p-value of less than 0.05 for the general linear regression analysis or other variables of known clinical relevance included were for further multiple linear regression analysis. A p-value of less than 0.05 was considered statistically significant. The models used demographic such as age, gender, nationality, and comorbidity, length of stay (LOS), and clinical characteristics such as disease severity and infection site, as covariates. All statistical analyses were performed using Stata, version 12 (StataCorp LP, College Station, TX, USA).

Results

Demographic and clinical characteristics

Two hundred two patients had confirmed SARS-CoV-2 infection during the study period. The mean age was 40.1 years, and 41.6% of the patients were female. Most patients, 180 (89.1%), only had mild symptoms, and 22 (10.9%) presented with severe illness. Among the severe cases, four

Table 1. Demographic characteristics of patients by disease severity

Characteristic	Disease severity; n (%)		p-value
	Mild (n=180)	Severe (n=22)	
Age (year); mean±SD	38.7±14.8	51.9±14.4	<0.001
Sex: male	102 (56.7)	16 (72.7)	0.149
Nation: Thai	162 (90.0)	21 (95.5)	0.408
Diabetes mellitus	5 (2.8)	8 (36.4)	<0.001
Hypertension	18 (10.0)	8 (36.4)	0.001
Dyslipidemia	7 (3.9)	2 (9.1)	0.264
HIV infection	1 (0.6)	1 (4.6)	0.074
Ischemic heart disease	1 (0.6)	3 (13.6)	<0.001
Lung disease	1 (0.6)	2 (9.1)	0.002
Length of stay (day); mean±SD	12.6±8.1	20.6±10.3	<0.001
Respiratory tract infection: lower	57 (31.7)	22 (100)	<0.001

HIV=human immunodeficiency virus; SD=standard deviation

Table 2. Demographic characteristics of patients by infection site

Characteristic	Respiratory tract infection site; n (%)		p-value
	Upper RI (n=123)	Lower RI (n=79)	
Age (year); mean±SD	33.9±12.5	49.7±14.3	<0.001
Sex: male	63 (51.2)	55 (69.6)	0.010
Nation: Thai	113 (91.9)	70 (88.6)	0.438
Diabetes mellitus	3 (2.4)	10 (12.7)	0.004
Hypertension	6 (4.9)	20 (25.3)	<0.001
Dyslipidemia	4 (3.3)	5 (6.3)	0.301
HIV infection	1 (0.8)	1 (1.3)	0.751
Ischemic heart disease	0 (0.0)	4 (5.1)	0.012
Lung diseases	0 (0.0)	3 (3.8)	0.029
Length of stay (day); mean±SD	11.8±8.4	15.9±8.5	0.001
Severe symptoms	0 (0.0)	22 (27.9)	<0.001

RI=respiratory tract infection; HIV=human immunodeficiency virus; SD=standard deviation

patients died. Pneumonia was the most common diagnosis (39.1%), followed by the common cold (32.7%), acute tracheobronchitis (15.8%), and acute pharyngitis (12.4%). The mean onset duration was 5.5 days. The mean LOS was 13.4 days. The demographic characteristics of patients by disease severity and infection site are presented in Table 1 and 2, respectively. Patients with severe symptoms were older, 72.7% were male, of Thai nationality, and had a higher comorbidity rate and longer LOS. They were more likely to have an LRI than patients with mild symptoms. Patients with LRI were older, 69.62% were male, had a higher comorbidity rate,

Table 3. Proportions of COVID-19 patients using healthcare resources by disease severity

Healthcare resource	Severity			
	Mild (n=180)		Severe (n=22)	
	Unadjusted	Adjusted	Unadjusted	Adjusted
Antibiotic (%)	25.6*	28.8*	90.9*	90.5*
Antivirus (%)	47.2*	49.3*	100*	100*
Chloroquine (%)	49.4*	51.3*	68.2*	33.3*
Hydroxychloroquine (%)	13.9*	13.6*	59.1*	57.8*
Oxygen therapy (%)	10*	12.2*	95.5*	100*
Medication (%)	97.2*	98*	100*	100*
Home medication (%)	53.9*	57.8*	50*	51.4*
Blood transfusion (%)	0.0	0.0	13.6	12.2
X-ray investigation (%)	95*	95.6*	100*	100*
Special investigation (%)	7.8*	7.4*	36.4*	25.1*
Medical devices (%)	91.7*	92.4*	100*	100*
Procedures (%)	0.6	0.5	36.4	13.9
LOS (day); mean±SD	12.6±8.1*	12.9±0.6*	20.6±10.3*	18.2±2.9*

LOS=length of stay; SD=standard deviation

Covariate adjusted: age, gender, nation, comorbidity (diabetes, hypertension, dyslipidemia, ischemic heart disease, human immunodeficiency virus infection, lung disease, other diseases)

* Statistically significant (p<0.05)

and a longer LOS than URI patients. Antibiotic and antiviral drugs were prescribed in 32.7% and 53%, respectively. The three most common antibiotics were azithromycin (22.3%), meropenem (3.5%) and piperacillin-tazobactam (3.5%), while the three most common antiviral drugs were favipiravir (30.2%), lopinavir/ritonavir (31.7%) and ritonavir (24.3%).

Healthcare resource utilization

The simple linear regression analyses showed the proportion of healthcare resource usage adjusted by age, gender, nation, and comorbidity covariates. In addition, the analyses compared mild and severe symptom patients (Table 3) and upper and lower respiratory tract infection patients (Table 4). Before and after adjusting by covariates, patients with severe symptoms and LRI were associated with a higher proportion of resource usage and longer LOS than patients with mild symptoms and URI, except for chloroquine and home medications that are often used by patients with mild symptoms.

Healthcare costs

The mean total cost per patient was 6,626 USD (756 to 45,586). The mean treatment cost per patient was 326 USD. The PPE costs were the most

Table 4. Proportions of COVID-19 patients using healthcare resources by respiratory tract infection site

Healthcare resource	Respiratory tract infection site			
	Upper RI (n=123)		Lower RI (n=79)	
	Unadjusted	Adjusted	Unadjusted	Adjusted
Antibiotic (%)	17.9*	20*	55.7*	54.7*
Antivirus (%)	29.3*	34.2*	89.9*	88.5*
Chloroquine (%)	41.5*	42.1*	67.1*	62.1*
Hydroxychloroquine (%)	11.4*	12.6*	30.4*	32.8*
Oxygen therapy (%)	0.8*	1.4*	48.1*	43.7*
Medication (%)	95.9*	97.1*	100*	100*
Home medication (%)	49.6*	50.7*	59.5*	54.9*
Blood transfusion (%)	0	0	3.8	1.3
X-ray investigation (%)	92.7*	93*	100*	100*
Special investigation (%)	4.9*	8.7*	20.3*	20.3*
Medical devices (%)	91.9*	92.2*	93.7*	94.9*
Procedures (%)	0.8	0.3	3.8	2.3
LOS (day), mean (SD)	11.8±8.4*	11±0.8*	15.9±8.5*	15.2±1.1*

RI=respiratory tract infection; LOS=length of stay; SD=standard deviation

Covariate adjusted: age, gender, nation, comorbidity (diabetes, hypertension, dyslipidemia, ischemic heart disease, human immunodeficiency virus infection, lung disease, other diseases)

* Statistically significant (p<0.05)

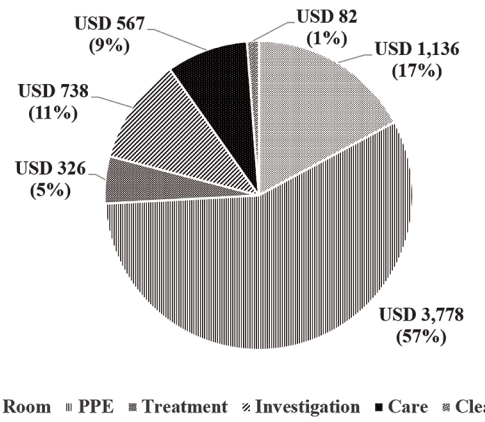

Figure 1. Mean and proportion of healthcare costs for hospitalized patients with COVID-19.

significant at 3,778 USD (57%) (Figure 1). The mean direct medical costs of hospitalized COVID-19 patients were 5,367 USD in URI cases and 8,585 USD in LRI cases. For patients with severe symptoms and LRI patients, there was an increase in HCCs compared to patients with mild symptoms and URI patients. Generalized linear modeling with a gamma distribution and log-link was used to assess the importance of covariate as age, gender, nationality,

Table 5. Multivariate generalized linear modelling

Factors	Coefficient (SE)	Relative increase in costs associated with variable (baseline=1)	p-value
Age	–0.0018 (0.0015)	–1.18	0.239
Sex*	0.0156 (0.0374)	0.42	0.677
Nation group**	–0.0387 (0.0629)	–0.61	0.539
Onset	–0.0052 (0.0039)	–1.34	0.181
LOS	0.0670 (0.0025)	26.76	<0.001
Diabetes mellitus	–0.0359 (0.0930)	–0.39	0.700
Hypertension	–0.0019 (0.0714)	–0.03	0.978
Dyslipidemia	0.0515 (0.1004)	0.51	0.608
HIV infection	0.1169 (0.1848)	0.63	0.527
Ischemic heart disease	–0.2292 (0.1540)	–1.49	0.137
Lung disease	–0.1512 (0.1563)	–0.97	0.333
Other disease	–0.0960 (0.0909)	–1.06	0.291
Disease severity***	0.2669 (0.0721)	3.70	<0.001
RI****	0.2188 (0.0474)	4.61	<0.001
Constant	7.7279 (0.0936)	82.63	<0.001

LOS=length of stay; RI=respiratory tract infection; HIV=human immunodeficiency virus

* Baseline category: male, ** Baseline category: Thai,
*** Baseline category: mild symptom, **** Baseline category: upper R0I

and comorbidity, onset, LOS, disease severity, and respiratory tract infection (Table 5). Age, gender, nationality, onset, and comorbidity were found not to be significant predictors of HCCs. Patients with longer LOS, severe symptoms, and lower respiratory tract infection (LRI) had higher cost and resource utilization value before and after adjusting for covariates.

Discussion

The present study was a retrospective cohort study of HCCs and HCRU among COVID-19 patients attending a single center. HCCs and HCRU were described and analyzed according to the disease severity and the respiratory tract infection site. The present study demonstrated the association between total HCCs and LOS, disease severity, and respiratory tract infection site in hospitalized patients with COVID-19 in developing countries. PPE was the major HCC, and patients with severe symptoms or LRI used more healthcare resources.

A major portion of the total direct medical cost of hospitalized patients infected with the H7N9 virus was medication, treatment, and laboratory testing (80%)[7]. In contrast, for the COVID-19 patients, PPE contributed to the largest proportion of the total

direct costs. This may be due to the lack of certainty about the transmission route of COVID-19 during the early pandemic period. Universal precautions with PPE resulted in no transmission from patients to healthcare workers in the hospital investigated. The cost of PPE was reduced after the transmission route was determined and the WHO established definitive recommendations for personal protection.

The length of hospital stay in the present study was similar to the previous study[2]. In Thailand, all patients with COVID-19 had to be hospitalized for infection control, and a negative PCR test was required for discharge. LOS was related to PPE and room expenditures, which contributed 74% of the direct medical costs of patients with COVID-19. The discharge and outpatient management policy for patients with COVID-19 should be revised to reduce hospital costs.

All healthcare resources were significantly higher in LRI cases. However, the total hospital cost per person in the present study was lower than the total hospital cost per person in the USA at 14,366 USD. Case management may be the main reason for this, as all COVID-19 patients, including those with mild symptoms, had to be admitted to hospital. In the USA, people with mild symptoms were managed by either a home visit or telephone consultation, which costs about 57 to 96 USD[9]. Mild cases, or patients with URI may be managed as outpatients to reduce costs, and a policy to enforce this model may be important to decrease the economic burden from COVID-19.

There are limitations to the present study. The inconsistent treatment protocol and use of ineffective medication in the early pandemic period impacted the treatment costs. The hospital setting in the present study was a referral hospital for severe cases, which influenced the high direct medical costs. More than half of the patients received antiviral drugs such as favipiravir, which was expensive.

Conclusion

In conclusion, HCCs of patients with COVID-19 were significantly associated with LOS, respiratory site infection, and disease severity. LRI and severe symptom patients consume more HCRU. PPE was the main component of the total costs. A specific precaution protocol and outpatient management may decrease the economic burden of COVID-19.

What is already known on this topic?

Healthcare costs for patients with COVID-19 depend on diseases severity and treatment models. In addition, healthcare costs are varied among countries.

What this study adds?

Healthcare costs of patients with COVID-19 are associated with length of stay, respiratory site infection, and disease severity. Lower respiratory tract and severe symptom patients consume more healthcare resource utilization. Personal protective equipment is the main expenditure in total cost.

Acknowledgement

The authors acknowledge Apichart Vachiraphan MD, Bamrasnaradura Infectious Diseases Institute, Department of Disease Control, Ministry of Public Health, Thailand, for administrative support.

Conflicts of interest

No potential conflict of interest relevant to this article was reported.

References

1. Guan WJ, Ni ZY, Hu Y, Liang WH, Ou CQ, He JX, et al. Clinical characteristics of coronavirus disease 2019 in China. N Engl J Med 2020;382:1708-20.
2. Mizumoto K, Chowell G. Estimating risk for death from coronavirus disease, China, January-February 2020. Emerg Infect Dis 2020;26:1251-6.
3. Shahriarirad R, Khodamoradi Z, Erfani A, Hosseinpour H, Ranjbar K, Emami Y, et al. Epidemiological and clinical features of 2019 novel coronavirus diseases (COVID-19) in the South of Iran. BMC Infect Dis 2020;20:427.
4. Cummings MJ, Baldwin MR, Abrams D, Jacobson SD, Meyer BJ, Balough EM, et al. Epidemiology, clinical course, and outcomes of critically ill adults with COVID-19 in New York City: a prospective cohort study. Lancet 2020;395:1763-70.
5. Pongpirul WA, Wiboonchutikul S, Charoenpong L, Panitantum N, Vachiraphan A, Uttayamakul S, et al. Clinical course and potential predictive factors for pneumonia of adult patients with Coronavirus Disease 2019 (COVID-19): A retrospective observational analysis of 193 confirmed cases in Thailand. PLoS Negl Trop Dis 2020;14:e0008806.
6. Qi X, Jiang D, Wang H, Zhuang D, Ma J, Fu J, et al. Calculating the burden of disease of avian-origin H7N9 infections in China. BMJ Open 2014;4:e004189.
7. Huo X, Chen LL, Hong L, Xiang LH, Tang FY, Chen SH, 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 Poverty 2016;5:79.
8. Xiao F, Chen BW, Wu YF, Wang YX, Han DM. Analysis on the cost and its related factors of clinically

confirmeds severe acute respiratory syndrome cases in Beijing. Zhonghua Liu Xing Bing Xue Za Zhi 2004;25:312-6.
9. Bartsch SM, Ferguson MC, McKinnell JA, O'Shea KJ, Wedlock PT, Siegmund SS, et al. The potential health care costs and resource use associated with COVID-19 in The United States. Health Aff (Millwood) 2020;39:927-35.