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Financial Burden and Average Cost of COVID-19 per Patient Admitted to the Intensive Care Unit in Kuwait

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ABSTRACT

Introduction: COVID-19 pandemic imposed a massive impact on constrained healthcare resources especially Intensive Care Units beds. Nevertheless, few studies have explored direct medical costs of ICU admissions and the financial burden associated with them.
Aim: Our aim is to estimate the average direct medical cost of COVID-19 admitted to ICU per patient and per diem as well as the associated financial burden.
Methods: A stochastic financial model was developed in accordance with Kuwait Task Force guidelines for COVID-19 management in ICU.
Results: Our results showed the average cost of COVID-19 patients admitted in the ICU per patient and per diem to be 16,471 KWD (54,354 USD) and 1,643 KWD (5,422 USD) respectively. While the financial burden over one fiscal year amounted to 15,795,689 KWD (52,125,774 USD).
Conclusion: This estimate can guide policy makers, researchers and financial analysts to follow a data driven decisions in planning and budgeting healthcare resources for this concurrent event or similar future events.

Keywords: Hospital Reimbursement Rate, Financial Burden, Direct Medical Cost, Cost Per Diem, Cost Per Patient.

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Authors' contributions
The participation of each author corresponds to the criteria of authorship and contributorship emphasized in the Recommendations for the Conduct, Reporting, Editing, and Publication of Scholarly work in Medical Journals of the International Committee of Medical Journal Editors. Indeed, all the authors have actively participated in the redaction, the revision of the manuscript, and provided approval for this final revised version.

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Conflict of interest
The authors declare that there is no conflict of interest regarding the publication of this article.

1. INTRODUCTION

In March 2020, the World Health Organization declared the novel Coronavirus disease of 2019 COVID-19 as a world pandemic [1]. Since the declaration date more than thirty studies have been published from Kuwait alone on matters of clinical characteristics, management, outcomes and public health measures which were compiled into forming the Kuwait Task Force Recommendations for the management of COVID-19 patients [2]. However, no single report was conducted to deal with the direct medical costs of COVID-19 in Kuwait. Among other things, one of the key challenging questions that healthcare providers and payers around the world are facing is what the reimbursement rate for this novel emerging disease should be like? In the United States (US), a report showed that for hospitalized COVID-19 patients, hospitals median reimbursement rates were only half that of the median costs inflicted by these patients [3]. Meanwhile a report from the European Observatory on Health Systems and Policies, called for protecting hospitals revenues by adequately adjusting reimbursement rates for COVID-19 related care [4]. To help with answering this question, it is essential to estimate the average cost of hospitalized COVID-19 Patients especially the critical cases admitted to the Intensive Care Unit (ICU). Such estimate can be used by researchers and policy makers in matters of economic evaluation, policy analysis and hospital reimbursement rates in the state of Kuwait in the view of data driven decision-making. Our aim is to estimate the average direct medical cost of COVID-19 patients admitted to the ICU and financial burden over a fiscal year 2020/2021 from the perspective of the Ministry of Health (MOH) in Kuwait.

2. METHODS

A stochastic financial model was developed in Microsoft Excel (version 16.54) to estimate the average direct medical cost of COVID-19 patient admitted to ICU and the acute medical complications directly attributed to COVID-19 such as Adult Respiratory Distress Syndrome (ARDS), Acute Cardiac Injury (ACI), Acute Renal Injury (ARI), Shock,

Cytokine Storm Syndrome (CSS), Pulmonary Embolism (PE) or Deep Venus Thrombosis (DVT), Seizure, Stroke, Coagulopathy or Disseminated Intravascular Coagulation (DIC) and Skin lesions [5]. Clinical parameters were obtained from local and international published sources in keeping with the management guidelines indicated by Kuwait Task Force Recommendations for the Management of COVID-19 patients [2]. These includes routine investigations and treatment for all patients admitted to the ICU as well as indicated investigations and treatments pertaining to specific complication.

Costs data were obtained from the Budget Control and Financial Affairs Department in the MOH for the pre-pandemic period of 2017-18, where costing follows mixed methods including top-down approach and micro-costing which are provided as unit costs (average cost per unit of care per patient, be it a test or drug or procedure or one day stay in ICU) with standard deviation (SD) derived directly from the average estimation or from application of 10% uncertainty range. Clinical parameters were assigned to beta distribution, while length of stay (LOS) and costs were assigned to gamma distribution because they are known to be rightly skewed [6]. Next, we ran Monte Carlo simulation with 10,000 iterations to calculate the average probabilistic estimate per ICU COVID-19 patient and per patient per diem. Furthermore, the average probabilistic estimate per patient was used to compute the total cost of all critical patients admitted to ICU over a fiscal year from April 2020 to March 2021 in MOH affiliated hospitals [7]. Clinical parameters are displayed in Table 1, while costs data are displayed in Table 2. Costs are reported in Kuwaiti Dinars while results are reported in Kuwaiti Dinars (KWD) and converted to United States Dollars (USD) at an exchange rate of 1 KWD = 3.3 USD, dated February 22nd 2022 (www.xe.com).

Table 1: Clinical parameters

Clinical Parameters	Frequency	Probability (α, β)	Source
COVID-19 Polymerase Chain Reaction (PCR), Respiratory viral panel PCR, Pneumonia PCR panel, Methicillin-resistant Staphylococcus aureus nasal screen.	1-2	1	[2]
Complete blood count, coagulation screen, D-dimers, hepatic profile, renal and electrolytes profile, C-reactive protein, procalcitonin, Troponin, creatine kinase, myoglobin, ferritin, lactate dehydrogenase, serum interleukin-6, septic screen (blood, urine, sputum), chest x-rays, arterial blood gases, erythrocyte sedimentation rate.	LOS	1	[2]
Antibiotics, antivirals, corticosteroids, anticoagulation, Hydroxychloroquine.	LOS	1	[2]
Noninvasive ventilation	LOS	0.23 (24,79)	[8]
Mechanical ventilation	LOS	0.77 (79,24)	[8]
Extracorporeal Membrane Oxygenation (ECMO)	LOS	0.087 (9,94)	[8]
Continuous renal replacement therapy (CRRT)	LOS	0.171 (17,82)	[9]
Chest computerized tomography (CT) scan	1-2	0.95 (78,4)	[10]
Nitric oxide inhalation (iNO)	LOS	0.95 (78,4)	[10]
Intravenous fluids (IVF) Resuscitation	LOS	0.682 (56,26)	[10]
Inotropes	LOS	0.71 (73,30)	[8]
B-type natriuretic peptide (BNP)	LOS	0.34 (28,54)	[10]
Cardiac Echocardiogram	1-2	0.34 (28,54)	[10]
Interleukin 1,8 and Soluble tumor necrosis factor receptor-1	LOS	0.72 (72,27)	[9]
Anti-interleukin-1 agents, anti-interleukin-6 agents	LOS	0.013 (4,311)	[11]
Disseminated Intravascular Coagulation screen (DIC)	LOS	0.03 (3,97)	[12]
Blood products (Fresh frozen plasma, Platelet concentrate,	LOS	0.03 (3,97)	[12]

Fibrinogen concentrate, Cryoprecipitate, Prothrombin complex concentrate)			
Antiepileptics	LOS	0.075 (6,73)	[13]
Head computerized tomography (CT) scan	1-2	0.043 (4,88)	[14]
Thrombolysis (tissue plasminogen activator)	LOS	0.043 (4,88)	[14]
Duplex Ultrasound	1-2	0.34 (31,61)	[14]
Computed Tomographic Pulmonary Angiography (CTPA)	1-2	0.34 (31,61)	[14]
Dermatology consultation	1-2	0.2 (18,70)	[2]
COVID-19 convalescent plasma	1-2	0.03 (3,100)	[8]
Length of Stay (LOS)	-	11 (11.81,0.93)	[8]

Table 2: Unit costs (per patient)

Item	Unit cost (KWD)	SD
Dermatology consultation	47.2	9.5
ICU Stay per diem	385.2	90.3
Noninvasive ventilation per diem	25	5.2
Mechanical ventilation per diem	190	20.1
Extracorporeal Membrane Oxygenation (ECMO) per diem	2650	510.2
Continuous renal replacement therapy (CRRT) per diem	921	110.4
COVID-19 PCR	10	1
Respiratory viral panel PCR	25	2.5
Pneumonia PCR panel	35	3.5
Methicillin-resistant Staphylococcus aureus nasal screen	1.25	0.125
Complete blood count	2	0.2
Coagulation screen	4	0.4
D-dimers	3	0.3
Hepatic profile	5	0.5
Renal and electrolytes profile	4	0.4
C-reactive protein	3.3	0.33
Procalcitonin	5	0.5
Troponin	2.25	0.225
Creatine kinase	2.25	0.225
Myoglobin	2.25	0.225
Ferritin	1.12	0.112
Lactate dehydrogenase	0.5	0.05
Muscle relaxants	4	0.4
Serum interleukin-6	15.8	1.58
Septic screen (blood, urine, sputum)	10	1
Chest x-rays	19	1.9
Arterial blood gases	3	0.3
Erythrocyte sedimentation rate	1.12	0.112
Antibiotics (Ceftriaxone, Moxifloxacin, Azithromycin, Doxycycline, Levofloxacin, Piperacillin/Tazobactam, Teicoplanin, Meropenem, Cefepime, Amikacin, Linezolid)	26.9	2.69
Antivirals (Remdesivir, Lopinavir-ritonavir, Favipiravir, Oseltamivir)	144.3	14.43
Corticosteroids (Dexamethasone, Hydrocortisone, Methylprednisolone, Prednisone)	7.2	0.72
Anticoagulation agents (heparin, enoxaparin, Fondaparinux)	32.28	3.228
COVID-19 convalescent plasma	210	21
Hydroxychloroquine	7	0.7
Anti-IL-1 Agents (Anakinra,	2214.5	221.45

Canakinumab, Rilonacept)		
Anti-IL-6 Agents (Tocilizumab, Sarilumab, Siltuximab)	669.1	66.91
Chest computerized tomography (CT) scan	69	6.9
Nitric oxide inhalation per diem	125	12.5
Intravenous Fluids (NS, Lactate Ringers, Dextrose)	2.21	0.221
Inotropes (norepinephrine, vasopressin, dobutamine)	14.95	1.495
Cardiac Echocardiogram	40	4
B-type natriuretic peptides (BNP)	11	1.1
Interleukin-1	15.8	1.58
Interleukin-8	15.8	1.58
Soluble tumor necrosis factor receptor-1	22.5	2.25
Disseminated Intravascular Coagulation screen (DIC)	14.4	1.44
Blood products (Fresh frozen plasma, Platelet concentrate, Cryoprecipitate)	75.3	7.53
Clotting factors (Fibrinogen concentrate, prothrombin complex concentrate)	237.42	23.742
Head computerized tomography (CT) scan	69	6.9
Antiepileptics (lorazepam, diazepam, phenytoin, Levetiracetam, valproate sodium)	11.96	1.196
Tissue plasminogen activator (alteplase)	466.4	46.64
Duplex Ultrasound	31	3.1
Computed Tomographic Pulmonary Angiography (CTPA)	108	10.8

3. RESULTS

The average cost per COVID-19 patient in the ICU is 16,471 KWD (54,354 USD) with a standard deviation 3,633 (11,989) resulting from Monte Carlo simulation as shown in Fig-1 and the Median is 16,186 KWD (53,414 USD).

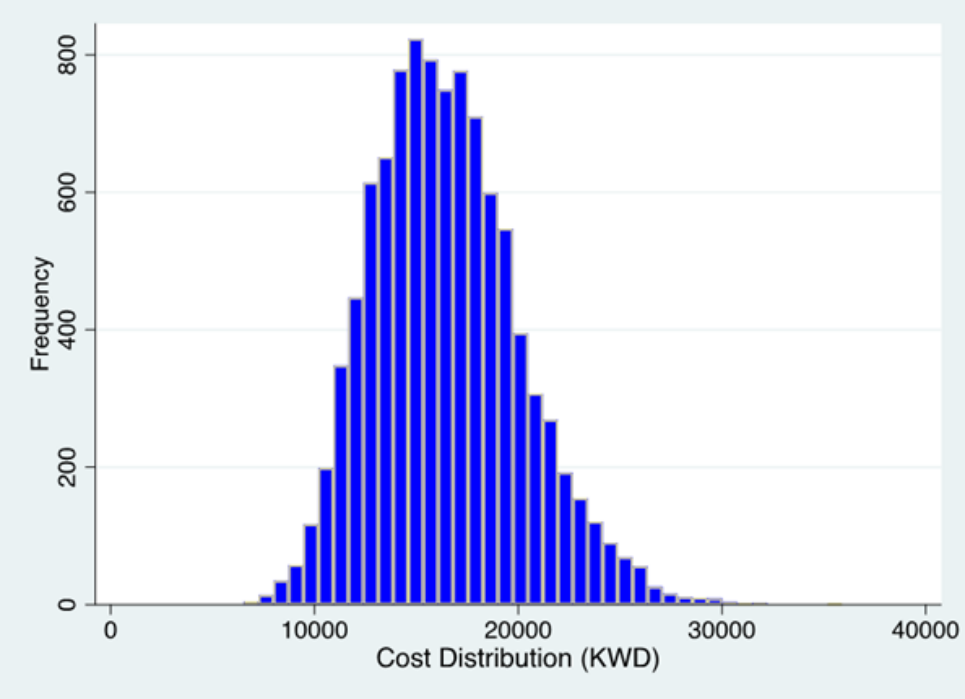

Fig 1: Monte Carlo simulation of the average cost of COVID-19 per patient

Meanwhile the average cost per patient per diem is 1,643 KWD (5,422 USD) with a standard deviation 641 (2,115) resulting from Monte Carlo simulation as shown in Fig-2 and the median is 1,521 KWD (5,019 USD). In addition, the financial burden associated with 959 ICU admissions through the fiscal year from April 2020 to end of March 2021 was 15,795,689 KWD (52,125,774 USD). Costly interventions that have significantly contributed to this high estimate includes mechanical ventilation, ECMO, CRRT, iNO, CT scans and ICU bed.

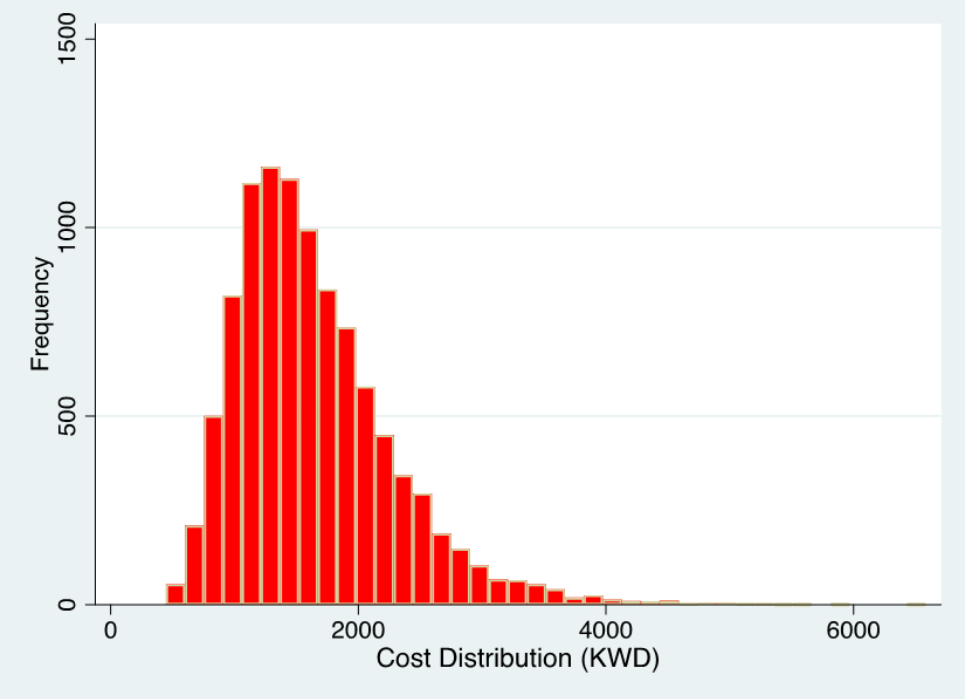

Fig 2: Monte Carlo simulation of the average cost of COVID-19 per patient per diem

4. DISCUSSION

This study is one of the very few studies to deal with costs of COVID-19 admitted to ICU in the region. We attempted to be as comprehensive as possible to cover management protocols in terms of investigations and treatments according to the Kuwaiti Task Force for COVID-19 management guidelines, and the clinical parameters in our model were mainly extracted from locally published sources. However, our model has several limitations. Firstly, the model is an approximation of reality, in other words it is not based on actual hospital expenditure, nevertheless models can capture wider range of events not captured by expenditure studies. Furthermore, during the pandemic, the government of Kuwait has relaxed the rules for budgeting and contracting. This facilitated contracting with private companies and suppliers for the provision of expensive Extracorporeal Membrane Oxygenation (ECMO) machines, specific COVID-19 drugs, mechanical ventilators and so on. Therefore, it had a major effect on the accounting practices which were relaxed too as a result of the pandemic disruption. In addition, many cases were admitted to newly launched Jaber Hospital, which was assigned as a major COVID-19 national hospital and accounting practices still not established. This was another reason for resorting to modelling rather than actual expenditure. Given that, we used the unit costs for the period 2017-18 before the pandemic. We did not concern ourselves with inflation or Consumer Price Index (CPI) to adjust our cost data because during 2020-21, the CPI bounced back to pre-pandemic 2017-18 levels after a deflation period in 2019-20. Therefore, the costs data were stable or closely similar. Secondly, our model did not offer cost stratification by gender, age or other clinical factors. Thirdly, we used mixed methods for costing which may have introduced potential double counting and overestimation despite our use of stochastic model which can handle uncertainties associated with the data to some extent. Fourthly, we have intentionally limited this study to direct complications rather than other associated co-morbidities because our concern was to establish a Kuwaiti-specific reimbursement rate for COVID-19 rather than other associated diseases which have their own rates.

Our average estimate is far higher than that reported in a regional study from Kingdom of Saudi Arabia which found the average cost of COVID-19 patient admitted to the ICU to be 21,178 USD, however their study didn't show cost structure, unit costs, or inclusion of certain costly interventions such as ECMO or anti-interleukin agents to allow further comparison and explanation of the difference in the estimate [15]. Another study from the United States (US) reported in mechanically ventilated ICU patients, the median costs were 47,454 USD and 41,510 USD for median LOS 16 and 11 days respectively [16]. Moreover, a far lower median cost was reported in China for about 16,940 USD [17]. Nevertheless, healthcare resources and costs are known to be different in different countries for several reasons such as costing methods used, pricing and utilizations of resources, timing and production factors among others [18].

Another important determinant of the average cost is the ICU admission criteria, including clinical scores and indications [11], where a lower threshold for admission means higher percentage of moderate cases with less costly interventions driving the average cost downward, while higher threshold means higher percentage of severe cases with costly interventions driving the average cost upwards.

The ongoing pandemic has significantly shifted care from elective cases to COVID-19 cases, eventually leading to higher operational costs and lower revenues for hospitals [19]. In this view, Germany was one of the earliest countries to address this financial burden and to pass a "Hospital Relief Act", to financially support hospitals occupied with COVID-19 patients [4]. We had similar experience in Kuwait, where budgeting and contracting rules were relaxed to provide the utmost care for patients from medical equipment to expensive drugs. More importantly, governments, healthcare providers and payers need to invest in costing research and timely publications of their findings which can guide healthcare financial systems and risk management to prepare for planning and budgeting in similar future events.

5. CONCLUSION

Our study is one of the very few studies in the region to estimate the average cost of COVID-19 patients admitted in the ICU per patient and per diem which was found to be 16,471 KWD (54,354 USD) and 1,643 KWD (5,422 USD) respectively. While the financial burden over one fiscal year amounted to 15,795,689 KWD (52,125,774 USD). Such estimate can guide policy makers, researchers and financial analysts to follow a data driven decisions in planning and budgeting healthcare resources.

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AUTHORS' CONTRIBUTIONS

The participation of each author corresponds to the criteria of authorship and contributorship emphasized in the Recommendations for the Conduct, Reporting, Editing, and Publication of Scholarly work in Medical Journals of the International Committee of Medical Journal Editors. Indeed, all the authors have actively participated in the redaction, the revision of the manuscript, and provided approval for this final revised version.

COMPETING INTERESTS

The authors declare no competing interests with this study.

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REFERENCES

[1] World Health Organization . WHO Director-General's opening remarks at the media briefing on COVID-19 11 March 2020. 2020. [Accessed 2022 May 31]. Available from: https://www.who.int/director-general/speeches/detail/who-director-general-s-opening-remarks-at-the-media-briefing-on-covid-19---11-march-2020

[2] Ministry of Health. Kuwait Adult Task Force Recommendation for Management of COVID-19 Adult patients. 2020. [Accessed 2022 May 31]. Available from: https://www.moh.gov.kw/UserRefs/Technical%20Dept/AdultC19.pdf

[3] Fair Health. Key Characteristics of COVID-19 Patients. A FAIR Health Brief. July 14 2020. [Accessed 2022 May 31]. Available from: https://s3.amazonaws.com/media2.fairhealth.org/brief/asset/Key%20Characteristics%20of%20COVID-19%20Patients%20-%20Profiles%20Based%20on%20Analysis%20of%20Private%20Healthcare%20Claims%20-%20A%20FAIR%20Health%20Brief.pdf

[4] Quentin W, Albreht T, Bezzina A, Bryndova L, Dimova A, Gerkens S, et al. Adjusting Hospital Inpatient Payment Systems For COVID-19. Eurohealth. 2020; 26 (2): 88 - 92. [Accessed 2022 May 31]. Available from: https://apps.who.int/iris/handle/10665/336287

[5] Potere N, Valeriani E, Candeloro M, Tana M, Porreca E, Abbate A, et al. Acute complications and mortality in hospitalized patients with coronavirus disease 2019: a systematic review and meta-analysis. Crit Care. 2020 Jul 2;24(1):389. DOI: 10.1186/s13054-020-03022-1

[6] Cantoni E, Ronchetti E. A robust approach for skewed and heavy-tailed outcomes in the analysis of health care expenditures. J Health Econ. 2006 Mar;25(2):198-213. DOI: 10.1016/j.jhealeco.2005.04.010

[7] Kuwait Government Online. COVID-19 updates (live). State of Kuwait. 2020. [Accessed 2022 May 31]. Available from: https://corona.e.gov.kw/en/Home/CasesByDate

[8] Ayed M, Borahmah AA, Yazdani A, Sultan A, Mossad A, Rawdhan H. Assessment of Clinical Characteristics and Mortality-Associated Factors in COVID-19 Critical Cases in Kuwait. Med Princ Pract. 2021;30(2):185-192. DOI: 10.1159/000513047

[9] Hajjar LA, Costa IBSDS, Rizk SI, Biselli B, Gomes BR, Bittar CS, et al. Intensive care management of patients with COVID-19: a practical approach. Ann Intensive Care. 2021 Feb 18;11(1):36. DOI: 10.1186/s13613-021-00820-w

[10] Alshukry A, Ali H, Ali Y, Al-Taweel T, Abu-Farha M, AbuBaker J, et al. Clinical characteristics of coronavirus disease 2019 (COVID-19) patients in Kuwait. PLoS One. 2020 Nov 20;15(11):e0242768. DOI: 10.1371/journal.pone.0242768

[11] Kipourou DK, Leyrat C, Alsheridah N, Almazeedi S, Al-Youha S, Jamal MH, et al. Correction to: Probabilities of ICU admission and hospital discharge according to patient characteristics in the designated COVID-19 hospital of Kuwait. BMC Public Health. 2021 Jun 22;21(1):1193. DOI: 10.1186/s12889-021-11146-4

[12] Zhou X, Cheng Z, Luo L, Zhu Y, Lin W, Ming Z, et al. Incidence and impact of disseminated intravascular coagulation in COVID-19 a systematic review and meta-analysis. Thromb Res. 2021 May;201:23-29. DOI: 10.1016/j.thromres.2021.02.010

[13] Waters BL, Michalak AJ, Brigham D, Thakur KT, Boehme A, Claassen J, et al. Incidence of Electrographic Seizures in Patients With COVID-19. Front Neurol. 2021 Feb 4;12:614719. DOI: 10.3389/fneur.2021.614719

[14] Fraissé M, Logre E, Pajot O, Mentec H, Plantefève G, Contou D. Thrombotic and hemorrhagic events in critically ill COVID-19 patients: a French monocenter retrospective study. Crit Care. 2020 Jun 2;24(1):275. DOI: 10.1186/s13054-020-03025-y

[15] Khan AA, AlRuthia Y, Balkhi B, Alghadeer SM, Temsah MH, Althunayyan SM, et al. Survival and Estimation of Direct Medical Costs of Hospitalized COVID-19 Patients in the Kingdom of Saudi Arabia Int J Environ Res Public Health. 2020 Oct 13;17(20):7458. DOI: 10.3390/ijerph17207458

[16] Ohsfeldt RL, Choong CK, Mc Collam PL, Abedtash H, Kelton KA, Burge R. Inpatient Hospital Costs for COVID-19 Patients in the United States. Adv Ther. 2021 Nov;38(11): 5557-5595. DOI: 10.1007/s12325-021-01887-4

[17] An X, Xiao L, Yang X, Tang X, Lai F, Liang XH. Economic burden of public health care and hospitalisation associated with COVID-19 in China. Public Health. 2022 Feb;203:65-74. DOI: 10.1016/j.puhe.2021.12.001

[18] Špacírová Z, Epstein D, García-Mochón L, Rovira J, Olry de Labry Lima A, Espín J. A general framework for classifying costing methods for economic evaluation of health care. Eur J Health Econ. 2020 Jun;21(4):529-542. DOI: 10.1007/s10198-019-01157-9

[19] Bai G, Zare H. Hospital Cost Structure and the Implications on Cost Management During COVID-19. J Gen Intern Med. 2020 Sep;35(9):2807-2809. DOI: 10.1007/s11606-020-05996-8