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TIME TREND OF INTENSIVE CARE COSTS FOR COVID-19 PATIENTS IN AN EGYPTIAN FEVER HOSPITAL

By

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Abstract

COVID-19 pandemic in Egypt was a part of the worldwide pandemic of coronavirus disease 2019 (COVID-19) caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). The virus was confirmed to have reached Egypt on 14 February 2020. This study evaluated the overall costs of treating COVID-19 patients from January 2020 to the end of December 2022 in a fever hospital.

Key words: Egypt, Covoid-19 patients, Treatment costs, Three years

Introduction

Intensive care units (ICUs) were critical in management of severe COVID-19 patients, required specialized equipment, skilled personnel, and extensive medical interventions (Tatsis *et al,* 2023). Pandemic trajectory has varied significantly across different phases and regions, influencing the demand for intensive care services. The emergence of variants of concern (VOCs) with mutations affected transmission, disease severity, or vaccine efficacy was a significant factor in the pandemic (Oelsner *et al,* 2024). COVID-19 treatment typically involves supportive care, symptom management, and monitoring for any complications and/or secondary infections (Nyasulu and Tamuzi, 2024). The longer a patient stays in ICU, the more resources are typically consumed, due to slow recovery progression or complications during hospitalization (Abuyousef *et al,* 2024). Panademic complexity and severity significantly contribute to the cost per stay in ICUs due to the intensive resources needed to treat risky patients (Thirumalai and Devaraj, 2024). To identify these factors helps health authorities to know resources effectively, optimize care delivery, and good feedback with new pandemic (Takala *et al,* 2022). Hermann *et al,* (2023) in France reported that pandemic needed to improve the working conditions and critical care workers to cope with human resources shortage. Kapinos *et al,* (2024) reported that to know average hospital costs for inpatient care during a pandemic was necessary for medical resource use, proving public health readiness and related policies. Hamar *et al.* (2024) added that COVID-19 over coats treatments can alleviate the burden on healthcare systems and society.

The healthcare policies can have long-term implications for overall healthcare spending and the allocation of resources across different levels of care, including ICUs (Brown *et al,* 2024). The adoption of innovative technologies and practices in ICUs, such as telemedicine or advanced monitoring systems, lead to more efficient care delivery and least costs over time (Abreu *et al,* 2024).

This study aimed to evaluate time trend of the intensive care costs for COVID-19 patients from January 2020 to the end of December 2022. Hypothetically there were significant differences in costs during this period.

Subjects and Methods

Study design and settings: This based analytic study was conducted in a fever hospital in Cairo with large numbers of COVID-19 cases who received the most internationally updated protocols of care.

Study sample: A total of 686 COVID-19 patients were admitted to the intensive care unit (ICU) from January 2020 to the end of December 2022. They were of both sexes and different ages. Those with incomplete or inaccurate records were excluded and the final sample consisted of 650 patients; 245 in 2020, 318 in 2021, and 87 in 2022.

Data collection: COVID-19 patients' data were collected for administrative purposes at the hospital level and were retrieved from the healthcare database. All positive patients were approved by the gold standard nucleic acid amplification tests.

Hospital Authority kindly allowed patients' records for research purpose that included demographic data, symptoms, and comorbid conditions, clinical outcomes, length of hospital stay (LOS), and all laboratory, radiological investigations, treatment, ICU services, and other costs in Egyptian Pounds (EGP).

Ethical approval: Study was carried out following the Helsinki Declaration. Confidentiality and data anonymity were guaranteed with total security to safeguard against any violations, or harmful changes or even foreseen risks were done.

Data management: Data was retrieved on Excel 11.0 sheets. Quality control was done with cleaning and revising for incomplete or inaccurate entries. Records with missed data were excluded. Statistical analysis was done using SPSS 20.0 (Statistical Package for Social Sciences) of IBM Corporation, USA. Descriptive data included frequencies and percentages for categorical variables, means standard deviations and medians for quantitative ones. Quantitative data were compared by Student t-test or non-parametric median tests. Spearman rank correlation assessed inter-relationships between quantitative variables, and ranked ones. If P value <0.05 was considered significant differences.

Results

Patients' demographics and medical characteristics showed increased in male patients' percentages. The symptoms and comorbidities were significantly higher in 2021. Those suffered from comorbidities, hypertension, diabetes, and cardiac problems showed significant differences in 2022, with significantly higher cytokine storm incidence, without significant difference in deaths.

COVID-19 costs of all patients showed significant increase in all estimated types (P<0.001). The overall CT costs of Ferritin and Dimer were high, but PCR costs declined without significant changes. Costs/patient significantly increased with Iverine, but deceased with chloroquine (P<0.001). Remdesivir, costs decreased from 2020 to 2021, and then increased from 2021 to 2022 (P<0.001). Actemra costs didn't change, but significant decreases were in costs of care and services, ICUs didn't decrease (P=0.085). Total costs/ patients declined from 2020 to 2021, but increased from 2021 & 2022 (P=0.004). LOS decreased, with comorbidities positive costs.

Details were in tables (1, 2, 3, 4 & 5) and figures (1 & 2).

Table 1: COVID-19 patients' demographics and medical characteristics

Variations	2020 (n=245)		2021 (n=318)		2022 (n=87)		X^2 Test	P-value
Male	173	70.6	268	84.3	76	87.4		
Female	72	29.4	50	15.7	11	12.6	19.649	<0.001*
Age	60.8±15.4		59.9±17.3		56.5±20.8		F=2.02	0.134
No. of symptoms	$3.8±1.5^{@\#}$		$4.5±1.9^{@\$}$		$2.0±0.9^{\#\$}$		F=70.932	<0.001*
Have comorbidity	175	71.4	233	73.3	50	57.5	8.369	0.015*
Hypertension	126	51.4	175	55.0	34	39.1	6.961	0.031*
Diabetes	124	50.6	155	48.7	36	41.4	2.211	0.331
Cardiac	42	17.1	87	27.4	11	12.6	13.248	0.001*
Chest	6	2.4	9	2.8	0	0.0	2.462	0.292
Renal	3	1.2	15	4.7	3	3.4	5.414	0.067
Hepatic	8	3.3	10	3.1	3	3.4	0.022	0.989
Stroke	7	2.9	11	3.5	5	5.7	1.582	0.453
Comorbidities no.	$1.4±1.2^{@}$		$1.7±1.4^{@\#}$		$1.2±1.3^{\#}$		F=6.359	0.002*
Cytokine storm	103	42.2	126	39.7	18	78.3	13.034	0.001*
Outcome: Cured	190	77.6	226	71.1	64	73.6		
Outcome: Dead	55	22.4	92	28.9	23	26.4	3.015	0.222

*, @, @, #.#, $.$=Significant at P<0.05

Table 2: Comparison of costs (EGP) per patient among COVID-19 patients.

Variations	2020 (n=245)	2021 (n=318)	2022 (n=87)	P= value
CBC:	114.9±43.5	134.1±43.9	182.6±47.0	
Median	140.0	140.0	210.0	<0.001*
ALT:	70.2±32.8	91.5±33.8	124.1±36.5	
Median	50.0	100.0	150.0	<0.001*
AST:	70.2±32.8	91.5±33.8	124.1±36.5	
Median	50.0	100.0	150.0	<0.001*
Urea:	98.6±45.5	128.8±46.7	174.6±51.1	
Median	70.0	140.0	210.0	<0.001*
Creatinine:	78.0±50.9	126.4±47.5	174.6±51.1	
Median	70.0	140.0	210.0	<0.001*
CRP:	8.8±19.1	26.6±28.2	891.4±810.0	
Median	0.0	25.0	700.0	<0.001*
CT:	536.3±270.2	611.3±322.8	760.3±365.1	
Median	450.0	450.0	900.0	<0.001*
Ferritin:	28.2±58.7	70.8±79.6	69.0±78.6	
Median	0.0	0.0	0.0	<0.001*
DIMER:	63.7±98.5	128.3±108.4	103.4±121.5	
Median	0.0	200.0	0.0	<0.001*
Interleukin (IL):	891.4±810.0	957.5±850.5	917.2±822.1	
Median	700.0	700.0	700.0	0.389
PCR:	1604.1±888.4	1150.9±580.3	1023.0±505.3	
Median	2000.0	1000.0	1000.0	<0.001*

*Significant at P<0.05

Table 3: Treatment and service/care costs (EGP) per patient among all COVID-19 patients.

Variations	2020 (n=245)	2021 (n=318)	2022 (n=87)	P-value
Iverzine	0.2±2.7	29.9±21.3	22.8±22.6	
Median	0.0	45.0	45.0	<0.001*
Chloroquine	3.5±7.6	1.8±7.1	0.5±4.3	
Median	0.0	0.0	0.0	<0.001*
SL:	591.4±253.9	482.1±324.6	88.5±234.0	
Median	700.0	700.0	0.00	NA
Actemra:	2654.4±3257.6	2253.7±3147.6	1754.3±2943.4	
Median	0.0	0.0	0.0	0.60
Remdesivir:	6582.9±7616.8	2801.5±5940.9	9886.9±7398.7	
Median	0.0	0.0	15360.0	<0.001*
Care/Service Staff:	8368.6±5573.1	7266.4±4530.2	6670.1±4123.1	
Median	7700.0	7000.0	6300.0	0.040*
Nutrition:	2391.0±1592.3	2076.1±1294.3	1905.7±1178.0	
Median	2200.0	2000.0	1800.0	0.040*
ICU:	14858.0±10314.5	12715.1±8239.2	12110.3±8150.4	
Median	13200.0	12000.0	10800.0	0.085
FU:	10759.6±7165.5	9342.5±5824.5	8575.9±5301.1	
Median	9900.0	9000.0	8100.0	0.040*

Table 4: Comparison of the total costs per patient among all COVID-19 patients over study period

Costs (EGP):	2020 (n=245)	2021 (n=318)	2022(n=87)	Median test (p-value)
Min-max	3310.0-140536.0	3570.0-142466.0	3310.0-113721.0	
M±SD	49773.9±27562.2	40486.6±23754.6	44668.1±24554.2	
Median	46870.0	37310.0	38950.0	0.004*
LOS: Min-max	1-38	1-34	1-27	
M±SD	12.0-8.0	10.4±6.5	9.5±5.9	
Median	11.0	10.0	9.0	0.04*

Table 5: Correlations between costs (EHP) and COVID-19 patients' characteristics

Variations	Spearman rank correlation			
	Investigations	Treatment	Care	Total cost
Year	0.019	-0.064	-0.098*	-0.119**
Age	0.020	0.116**	-0.003	0.030
No. of symptoms	-0.085*	-0.172**	-0.007	-0.096*
No. of co-morbidities	0.108**	0.079*	0.052	0.066

*Significant at p<0.05, **Significant at p<0.01

Discussion

The COVID-19 pandemic constituted an unparalleled burden on Intensive Care Units (ICUs). With amplified demands and limited supply, critical care resources were depleted, which required cost-effectiveness analyses to ration these limited resources to ensure the highest attainable quality of patient care (Koraishy and Mallipattu, 2023). Such a sizable economic impact of COVID-19 hospitalizations highlights the importance of a thoughtful revision of these costs for future healthcare planning (Rocha *et al,* 2023).

In the present study, time trend of intensive care costs for COVID-19 patients from January 2020 to end of December 2022 and tested the research hypothesis showed significant differences in the annual costs during this period. There were significant changes in costs of treatment, service/care, and total costs, which led to acceptance of the set research hypothesis.

In the present study, all patients were males. This agreed with Sharif *et al.* (2021) in Bangladesh, who reported that male patients were 65.8%. Also, agreed with Ghorbani *et al.* (2024) in Iran, who reported that patients (68.57%) were males.

In the present study, there were significantly less symptoms, comorbidities, diabetes, hypertension, and cardiac problems. This led to, at least in part, due to the lower disease intensity among patients that reduced care requirements and all costs. This agreed with Abdul Kader and Lami (2022) in Iraq, they found that the costs incurring multiple morbidities patients were significantly higher.

In the present study, mortality increased from 2020 to 2021 due to patients' increased severity during the epidemic peak, with depletion of resources and a deficiency in ICUs' beds available. But, the slightly decreased mortality in 2022 was due to the improved in treatments and vaccination. This agreed with Ahmad *et al.* (2022), they reported that in 2021 pandemic severest phase was due to spread of variants like Delta. Also, Truman *et al.* (2022) in USA, reported that the there was a decrease between 2020 and 2021 by vaccinations and more effective treatments.

In the present study, the significantly high symptoms and comorbidities cases in 2021 were due to higher death rate during that year, but without significant. This agreed with Moreno-Torres *et al.* (2022) in Spain, who reported that among COVID-19 patients survival hypertension and diabetes were significantly less prevalent compared to the dead ones Also, it agreed with Wondmeneh and Mohammed (2024) in Ethiopia who, found hypertension & diabetes were high in the dead patients.

In the present study, the showed that general investigations costs for a patient significantly increased throughout the study period, due to the rising costs of the kits and testing materials for the effects of along the inflateon on both national and international levels. This agreed with Sayed *et al.* (2022) who, in Saudi Arabia reported that significant increased in the CBC cost during the COVID-19 pandemic years.

In the present study, the specific investigations costs showed significant increase per patient of CT during the study period and in costs of Ferritin from 2020 through 2021, but PCR costs decreased during this period. The changes might be due to the high market price of testing materials, and frequency of using these tests for each patient. This agreed with Radmard *et al.* (2020), they an Iranian Multicenter COVID-19 survey found that chest CT for patients marked increases in chest CT costs during the epidemic. Also, agreed with Anan (2022), who reported that COVID-19 imposed a huge burden on the Egyptian healthcare system, which was only counted for publicly recorded cases

In the present study, the time trend of treatment costs per COVID-19 patient showed that Iverzine costs significantly increased, Chloroquine showed decreased, but Actemra cost didn't show any change during the study period. The discrepancies among these drugs costs were due to the frequency use of treatment protocols that changed over times, and the market price of some drugs. This agreed with Kapinos *et al.* (2024) in the United States, who reported that the treatment costs of COVID-19 patients followed the increased trend from 2020 to 2022 due to changes in the care practices, disease severity, and utilization resources.

In the present study, Remdesivir showed a significant decrease from 2020 to 2021, but with an increase from 2021 to 2022. This was due to the changes in the drugs' market price, and using a new drug FDA approved on October 2020 in treating the COVID-19. The drugs proved to be effective and were available on the 2nd to 3rd epidemic years. This agreed with Whittington *et al.* (2022), who reported that remdesivir price decreased on 2021.

In the present study, there was a decline in the mean costs of all care and service types in COVID-19 patients over the study period, due to the healthcare providers increased experience with COVID-19, mainly for severe cases where unnecessary procedures didn't improve them that reduced the costs. Also, this was due to the use of effective drugs as Remdesivir that minimized patients' hospital Length of Stay (LOS) and reduced costs. This agreed with Murton *et al.* (2022), they used remdesivir in COVID-19 treatment reported that its usage was associated with a 6% to 21.3% decline in bed occupancy. Also, this agreed with Torres-Toledano *et al.* (2023), who studied COVID-19 medical care costs, and found marked LOS decrease.

In the present study, cost/cured or life saved was computed as a measure by cost-effectiveness showed that intervented costs were compared to the relative effectiveness measured in non-monetary units like cured or life saved (Kim and Basu, 2021). The analyzing time trend of costs showed steady investigations costs, but the care costs declined. Treatment costs declined, but increased paralleling with Remdesivir trend and total costs decreased in 2021 and increased in 2022. This showed that cost-effectiveness was higher in 2021 as compared to 2020 and 2022, although death rate was higher during that year. Thus, resources had more wisely used given the available depletion resources at the epidemic peak. Faramarzi *et al.* (2024) reported that data highlight the economic impact of the COVID-19 on individuals and healthcare systems, showing the need for more financial support measures during the pandemics.

In the present study, total expenditure showed decreases in all categories in year 2022, especially for care/service costs, which was due to the small number of patients during this year as compared with the previous two years of COVID-19 epidemic regression. Also, care/service overall costs showed a slight more than three-fourths of total expenditure, as the interventions aimed was to improve COVID-19 cost-effectiveness of managing patients must mainly address the area. This agreed with Ferranna (2024), who studied the COVID-19 pandemic global burden at Southern California University found that care/service costs were 65% of total costs.

The present study reported some related costs of managing COVID-19 patients that were patient's age and comorbidities number positively correlated with the investigations costs, and were expected to add risks posed by being older and having chronic diseases, necessitated more diagnosis, and treatments. This agreed Adhikari *et al,* (2024); Tawde *et al,* (2024) in the USA. However, symptoms per patient negatively correlated with costs of investigations, treatment, and the overall ones. Such patients might have overt symptoms and needed less diagnosis. But, Anteneh *et al,* (2024) in an Ethiopian COVID-19 study, mortality showed that significant symptoms were predicted by hospital records emphasized clinical and economic variables.

Recently, WHO (2025) reported that since mid-February, global SARS-CoV-2 activity increased, with the positivity rate of 11%, levels since July 2024, and that as part of comprehensive COVID-19 control programs, vaccination remains a key intervention to prevent severe disease and deaths especially among the risk groups.

Conclusion

The management of COVID-19 patients in the intensive care units (ICUs) imposed the substantial financial burden with significant annual variations in the costs of investigations, treatment, and care/services.

This constitutes a big bulk of the total costs, but LOS declined by time reflecting potential improvements in care protocols and efficiency.

Recommendations

To reduce patients treatment costs and health care system: 1- Reduce barriers for deveopment of generic and bio-similar products, and expedite approval of certain generic applications 2- Improve coverage and reimbursement requirements to expand patient access and promote value. 3- Support chronic diseases treatment and prevention. 4- Training of the newly recruited ones is a must.

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Authors' contributions: All authors equally shared in the study, writing, reviewing the manuscript and approved its publication

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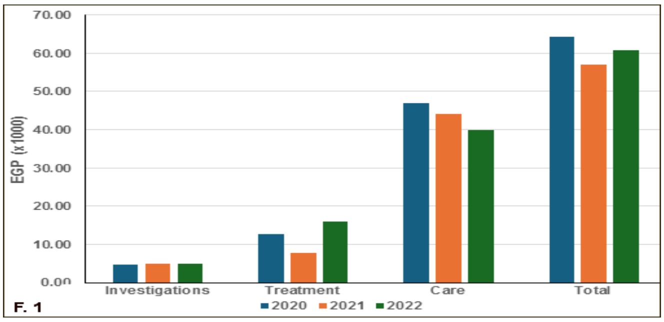
Explanation of figures

Fig. 1: Cost per saved life (total cost/number cured) among all COVID-19 patients.
Fig. 2: Total expenditure on COVID-19 patients during study period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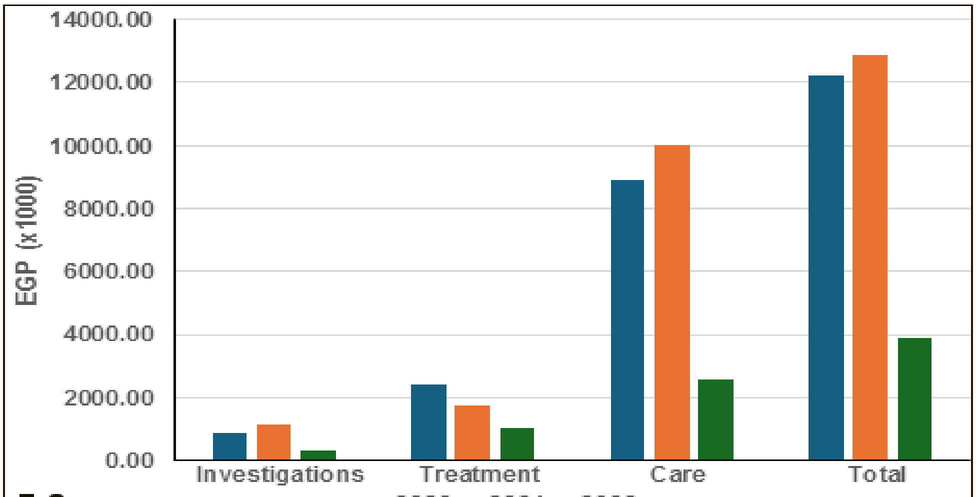
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12000.00
10000.00
8000.00
6000.00
4000.00
2000.00
0.00
EGP (x1000)
Investigations
Treatment
Care
Total
2020
2021
2022

F. 2