

The Cost of Clinical Management of SARS-COV-2 (COVID-19) Infection in Ghana: A Cost of Illness Analysis

Hamza Ismaila (✉ hamzaismaila@gmail.com)

Ghana Health Service <https://orcid.org/0000-0002-6697-5164>

James Avoka Asamani

World Health Organization: Organisation mondiale de la Sante

Virgil Kuassi Lokossou

ECOWAS Regional Centre for Disease Surveillance and Control

Ebenezer Oduro-Mensah

Ga East Municipal Hospital

Juliet Nabyonga-Orem

World Health Organization Regional Office for Africa: Organisation mondiale de la Sante pour Afrique

Samuel Kaba Akoriyea

GHS: Ghana Health Service

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The cost of clinical management of SARS-COV-2 (COVID-19) infection in Ghana: A cost of illness analysis

Authors:

¹Hamza Ismaila, MA., MBA., BA*.

²James Avoka Asamani, PhD Candidate, M.Phil., M.Sc., BSc, FWACN*

³Dr Virgil Kuassi Lokossou, MD, MPH, MSc

⁴Dr Ebenezer Oduro-Mensah, MD, MPH, MWACP, MGCPS

²Dr Juliet Nabyonga-Orem, PhD, MSc, MB CHB#

¹Dr Samuel Kaba Akoriyea, PhD, MD, Msc, EMGL, MPhil, MoID, FGCPs#

*Co-first Authors

#Co-Supervising Authors

1. Ghana Health Service, Headquarters Office, Accra
2. World Health Organisation, Regional Office for Africa, UHC Life Course Cluster, Intercountry Support Team for Eastern and Southern Africa, Zimbabwe
3. ECOWAS Regional Centre for Disease Surveillance and Control, Abuja
4. Ga East Municipal Hospital, Ghana Health Service, Accra

Address Correspondence to:

Hamza Ismaila
Ghana Health Service, Headquarters Office
Private Mail Bag, Ministries, Accra
Ghana
hamzaismaila@gmail.com

ABSTRACT

Background: As the global strategies to fight the SARS-COV-2 infection (COVID-19) evolved, global response strategies impacted the magnitude and distribution of health-related expenditures. Although the economic consequence of the COVID-19 pandemic has been dire, and its true scale yet to be ascertained, one key component of the response is the management of infected persons which its cost has not been adequately examined, especially in the context of African countries.

Methodology: To partly fill gaps in context-specific cost of treating COVID-19 patients, we adopted a health system's perspective and a bottom-up, point of care resource use data collection approach to estimate the cost of clinical management of COVID-19 infection in Ghana.

Findings: We found that resource use and average cost of treatment per COVID-19 case varied significantly by level of disease severity and treatment setting. The cost of treating COVID-19 patients in Ghana from the perspective of the health system ranged from US\$282 (GH ₵1,629) to US\$23,382 (GH ₵135,149), with an average of US\$11,925 (GH ₵68,929). The cost of treatment increased by at least 20 folds once a patient moved from home management to the treatment centre. PPEs and Transportation were the main cost drivers for institutionalised care, whilst investigations (COVID-19 testing) and staff time were for home-based care.

Conclusion: Cost savings could be made by early detection and effective treatment of COVID-19 cases, preferably at home, before any chance of deterioration to the next worst form of the disease state, thereby freeing up more resources for other aspects of the fight against the pandemic. Policy makers in Ghana should thus make it a top priority to intensify the early detection and case management of COVID-19 infections.

Keywords: Cost of COVID-19, Cost of Illness Analysis, COVID-19, Case management of COVID-19, bottom-up, point of care resource use, costing.

INTRODUCTION

In December 2019, an unknown respiratory illness was reported in the Hubei Province of China, a disease later named COVID-19 caused by Severe Acute Respiratory Syndrome Coronavirus type-2 (SARS-COV-2) (1). The disease subsequently spread globally and was declared a pandemic by the World Health Organization (WHO) in March 2020 (2). As of 17 September 2020, there have been 29,679,284 confirmed cases globally and 936,521 deaths while the WHO African Region has recorded 1,127,164 confirmed cases and 24,294 deaths (3, 4). In Ghana, the disease was first reported on 12th March 2020 and by 17 September 2020 about 45,655 have been reported with a case fatality rate of less than 1% (5).

Given the alarming basic case reproduction rate of the virus globally, the WHO implored countries to “aggressively double down to contain it” (6). Learning from the West Africa Ebola crisis between 2013 and 2016, effective case management, public health containment measures, community empowerment and partnership became a central part of the pandemic response (7). As most were not yet fully prepared, varied risk-based containment strategies were employed (8); initially centred on travel restrictions, evolving into partial and complete lockdowns to drastically limit physical interactions with the intent of curbing the spread of the virus while aggressive treating infected persons (9). These strategies have evolved over time and tend to vary substantially from country to country.

Although the economic consequence of the COVID-19 pandemic had been dire, and its true scale yet to be ascertained, one key component of the response is the management of infected persons which its cost has not been adequately examined. Earlier studies in China estimated the mean cost of treating COVID-19 patient to be about US\$6827 which roughly amounted to US\$ 0.49 billion for the entire clinical management of COVID-19 in China (10), whilst those of the African Region focussed on generating regional averages of US\$3.65 for a mild case and US\$15.56 for a hospitalized patient (11) . However, these estimates were premised on effective prevention measures (wide scale and intensive social distancing) which were not met.

There are very limited country-specific analyses that estimate the cost of treating COVID-19 cases in Africa. One Kenyan analysis estimated the cost of treating COVID-19 patients to range from US\$282 in home management to US\$5,707 in critical care settings (12). In another attempt to estimate the probable cost of the entire response to COVID-19, Rueda et al extrapolated data from costing of other diseases in South Africa, Ethiopia and Pakistan to low-

and-middle-income countries. The authors estimated the cost of treatment between US\$147 in home-based management to US\$1,082 per day for critically ill patients managed in resource-intensive settings (13). However, as the characteristics of the pandemic evolved, so did the global strategies, which ultimately impacted on the case management and overall response of countries. The wide variations in case management protocols between countries has made it even imperative for context-specific estimation of the cost of treatment as part of the needed evidence towards the adoption of sustainable policies and priorities on COVID-19 interventions. To partly fill gaps in context-specific cost of treating COVID-19 patients, we adopt a health system's perspective and a bottom-up, point of care resource use data collection approach to estimate the cost of clinical management of COVID-19 infection in Ghana.

METHODOLOGY

We employed a costing approach guided by the costing framework proposed by Drummond (14) and based on the approved national COVID-19 treatment protocol for Ghana (15). We adopted a bottom-up, point of care resource use data collection approach. Resource use for each type of patient (according to disease severity) was identified and quantified using patient-level data guided by the advice of case management experts in the frontline of COVID-19 management in the country.

The perspective of cost: The Ministry of Health fully bore the cost of COVID-19 treatment; hence the Ministry's perspective of the cost was adopted for this analysis. The costs related to loss of income to patients were not taken into account, same for loss of revenue to health facilities due to reduced utilization of other routine services arising from the suspension of such services or patients not demanding for them for fear of the COVID-19 pandemic.

Resource use identification and quantification per patient by the level of severity: The COVID-19 treatment protocol of Ghana as of June 2020 was reviewed together with clinicians to identify resource use elements for the different levels of disease severity and setting of treatment (home or institutionalised care) which culminated in the development of resource use identification template. The resource template was used to collect data, with the assistance of frontline clinicians, on the resources used to treat each type of patient (by the level of disease severity and treatment setting), and the quantity of the resources used. The identified resource use with quantities was validated by two of the country's leading experts in COVID-19 case management and further reviewed by the case management Team Lead of the West African

Health Organisation (WAHO). The resource use was categorised into five (5): overheads (patient accommodation, utilities, feeding and toiletries, as well as set of personal protective equipment used by the health professionals), investigations, medications, in-patient care and human resources (staff time). In the case home isolated patients, we considered costs relating to provided items (thermometer, cost of visits and staff time). Ghana's treatment protocol for COVID-19 specified that all moderate, severe or critically ill patients be treated in hospitals while those with no or mild symptoms are supported to manage at home or at isolation centers where the home environment is deemed inconducive for isolation.

Assigning unit cost for each unit of resources used: The unit cost of the resources used in treating COVID-19 patients were triangulated from Ghana's National Health Insurance Scheme (NHIS) price list for medicines and services (16, 17), average prices from the Public Procurement Authority (18), the Government salary structure for public sector health workers (19) and invoices of goods that were procured that were hitherto not regularly procured (example Personal Protective Equipment, PPEs). Where the unit costs could not be obtained from these sources, local open market prices were used except for resources that were not on sale in the local market where the international prices were adopted.

Cost estimation per patient tenement: Using the resources identified and quantified for each patient type, and the unit cost, the cost of treatment per patient (by the level of severity) was computed using the following formula:

$$Total\ cost\ of\ treatment\ for\ patient\ i = \sum_j (Resource_{ij} \times Unit\ cost_j)$$

Where

- $Resource_{ij}$ is the amount of resource j used by patients with disease severity i
- $Unit\ cost_j$ is the unit cost for resource j

We compared the cost of treatment by the different categories of resource use within the same level of disease severity and across the different levels of disease severity as well as treatments settings – home-based care or institutionalised care. The estimated costs were not discounted or adjusted for inflation since they were cross-sectional with no long-term extrapolation. The official exchange rate of 5.78 Ghana Cedis to US\$1 (as of end of August) was used for converting the cost from one currency to the other.

FINDINGS

Resource Use by the level of severity

Patients that received institutionalised care at isolation centres or hospitals were transported from their homes or point of referral to the treatment centre or hospital and sent back upon discharge. This was an essential part of the overhead cost alongside patient accommodation, feeding and toiletries, as well as set of personal protective equipment used by the health professionals. The resource need differentials in the overhead category were driven by the average length of stay, which was for up to 21 days for severely or critically ill patients and 19 days for the rest. Home managed patients received a thermometer for self-monitoring, and were paid visits by clinicians (staff time) which formed the overhead costs from the health system perspective.

Resources needed for investigations and monitoring of patient prognosis included materials for sample taking and reagents like test kits for SARS-COV-2 test, full blood count, blood gases, chemistries and coagulation profile. Other investigative procedures included x-rays, computer tomography (CT) scans, electrocardiogram (ECG) and ultrasound scans for pregnant women. The resources needed for, and frequency of, these investigations varied markedly depending on the severity of the disease. For instance, while all these were necessary for critically ill patients, analysing blood gases were not indicated for those classified as severe unless they were put on a ventilator (where oxygen saturation was less than 90% with a continuous downward trend in spite of optimal oxygenation or when significant lung changes were detected on x-ray or CT scan). Similarly, blood gases, CT-Scan, chemistries, ECG and coagulation profile were not included in the monitoring protocol for those with mild illness or those that were asymptomatic. For patients managed at home, only routine temperature checking, and the SARS-COV-2 test were needed.

Another category of resource use was medications, which the treatment protocol outlined the use of vitamin C with zinc, hydroxychloroquine (or chloroquine) and azithromycin for all patients regardless of the treatment settings. Patients with severe illness or those who required high dependency or intensive care received additional antibiotics such as ceftriaxone and thrombolytics (commonly enoxaparin).

Resources needed to facilitate the in-patient care of all institutionally managed patients included oxygen for patients who experienced difficulty in breathing, and mechanical

ventilation for critically ill patients, patients with severe symptoms and oxygen saturation of 90% or less, as well as for in-patients with significant lung changes on x-ray or CT scan. The use of oxygen and mechanical ventilation was concomitantly associated with the use of syringes, needles, oxygen masks, endotracheal tubes, among others.

The health workforce needed for the management of each case depended on the level of severity and availability of other resources. For example, severely ill patients required up to 4 hours of medical specialists' time and 6 hours of nurses' time per day – of various skill-mix. **Supplementary appendix 1** provides details of the resource needs identified for each level of the disease severity and the associated unit cost. The rest of the analysis was based on these resource use and unit costs.

Average cost of treatment per COVID-19 case – by level of disease severity.

The cost of treating COVID-19 patients in Ghana irrespective of the setting and level of severity from the perspective of the health system ranges from US\$282 (GH ₵1,629) to US\$23,382 (GH ₵135,149), with an average of US\$11,925 (GH ₵68,929). For patients that were treated in hospitals or treatment centres, the overhead cost notably for PPEs and Transportation were the main cost drivers, followed by the cost of in-patient care (see Table 1 for cost summary in USD and supplementary tables S1 – S5 for resource use and unit cost in local currency unit, the Ghana Cedis). For home management, the main cost drivers were investigations (COVID-19 testing) and staff time.

Table 1: Estimated cost of COVID-19 treatment by the level of severity and treatment setting (in United States Dollars, USD)

Cost Category	Cost of home management (USD)	Estimated cost by level of disease severity for institutionalised care (USD)				Average
		Mild	Moderate	Severe	Critical	
In-patient care	-	1,259	1,269	3,546	4,587	4,066
Investigations	132	147	340	277	489	277
Medications	14	14	89	199	335	130
Overheads	17	4,072	6,701	13,276	14,660	7,745
Staff time	118	215	1,552	3,007	3,312	1,641
Total	282	5,707	9,952	20,305	23,382	11,925

As shown in table 2, overhead cost on average accounted for 55% (6-71%) of the cost of clinical management COVID-19 cases in Ghana, followed by in-patient care which accounted for 19% (17-22%). Across all cases, the third cost driver was staff time, accounting for 18% (4-42%) of the treatment cost, followed by investigations which accounted for 11% (1-47%) of the total cost. Interestingly, medications constituted only 2% (0.02-5%).

It is worth noting that there was a wide range in the proportion of cost attributable to overheads, staff time and investigations. For example, there was a 65% cost differential between the overhead cost of patients managed at home and those managed in institutional settings; and across the different levels of disease severity of those that were institutionally managed. Eighty one percent (81%) of the overhead costs for institutionally managed patients were attributable to PPEs, 28% for accommodation and utilities, and 3% for transportation. To put this in perspective, critically ill patients who spent about 21 days in hospitals consumed up to 210 sets of PPEs for the duration of their stay as compared to 38 sets of PPEs consumed by patients with mild symptoms with an average length of stay of 19 days. Similarly, several investigations (and repeat investigations) were required for patients with increasing levels of severity, thereby accounting for 46% in the cost variation observed for investigations. Also, as level of severity increased, the expertise and number of health workforce (staff time) needed to address the patient health problem increased, hence a US\$10,588 difference between the staffing costs of treating mild and critically ill patients. This represents a 186% difference in the staffing costs between the extremes of the disease when managed in institutional settings.

Table 2: Proportional cost distribution by cost category, level of severity and treatment setting

Cost Category	Home management	Level of Disease Severity for Institutionalised Care			
		Mild	Moderate	Severe	Critical
In-patient care	0%	22%	13%	17%	20%
Investigations	47%	3%	3%	1%	2%
Medications	5%	0.2%	1%	1%	1%
Overheads	6%	71%	67%	65%	63%
Staff time	42%	4%	16%	15%	14%
Total	100%	100%	100%	100%	100%
Cost difference (US\$)		5,425	4,245	10,353	3,078
% Increase disease severity to another		1925.2%	74.4%	104.0%	15.2%

Cost differences in various levels of disease severity and treatment settings

Ghana's case management protocol for COVID-19 allows for patients without obvious symptoms and those with mild symptoms to be managed at home, if in the assessment of the clinician, the conditions necessary for effective management at home are met. These cases required fewer resources classified in the overhead's category, fewer clinical investigations, health workforce expertise and medications.

Once a patient moved from home management to the treatment centre, the cost of treatment increased by at least 20 folds. The criteria for managing a COVID-19 patient in a treatment centre/hospital included mild and asymptomatic cases whose home environment were evaluated to be un conducive for effective treatment. These patients were usually kept in COVID-19 isolation/treatment centres or specially designated areas in hospitals. Additionally, all moderate, severe and critically ill patients were managed in hospitals with the appropriate capacities to address their health needs. The cost of managing a patient with mild symptoms in isolation/treatment centre was estimated to be US\$5,707 (GH ₵32,985), with overheads accounting for about 71% of this cost while in-patient care and staff time accounted for 22% and 4% respectively.

The cost of treating patients with severe symptoms and the critically ill was about US\$20,305 (GH ₵117,361) and US\$23,382 (GH ₵135,149), respectively. Thus, deteriorating from moderate to severe resulted in about US\$10,353 (104%) additional cost, and a relatively marginal increase of 15.2% (US\$3,078 or GH ₵17,788) between patients with severe symptoms and those that are critically ill. Deterioration from mild to moderate required US\$4,245 (GH ₵24,536) worth of additional resource, representing a 74.4% increase in the cost of treatment.

DISCUSSION

There are limited number of publicly available works estimating the cost of COVID-19 response, including that of case management which is the thrust of this paper. In one multi-country study underpinned by extrapolation of data from South Africa, Ethiopia and Pakistan, the cost of managing COVID-19 cases ranged from US\$147 per patient in home management to as high as US\$1082 per case per day for critically ill (13). For home management, our estimate was, however, 92% higher than that of South Africa (for home-based management of non-symptomatic or mildly ill patients) as reported in the work of Rueda et al. The difference between the two studies was even much higher for severe cases where our estimate was ten

times higher. However, estimates of the two studies converged with a difference of less than 3% for the cost of treating critically ill patients (US\$1,113 per day estimated in the current study versus US\$1,082 per day in the previous study). Whereas we adopted a bottom-up, point of care resource use data collection approach, Rueda and colleagues were unable to collect primary cost data directly from COVID-19 service delivery points, hence approximated resource use and unit costs from previous works around tuberculosis (TB) or general health services. Thus, the difference in methodological approaches may have contributed to the differences in cost, in addition to the contextual and treatment protocol differences that may exist between Ghana (where the present study was based) and South Africa, Ethiopia and Pakistan (whose context was the basis of the previous work).

In a Kenyan study, Barasa et al estimated the cost of treating COVID-19 cases in Kenya as ranging from US\$278 per asymptomatic or mildly ill patient in home management to US\$5,879 per critically ill patient managed in resource-intense settings (12); drawing close similarities with current estimates from Ghana's context for home-based management (US\$282 for Ghana versus US\$278 for Kenya). However, the estimated cost of treating critically COVID-19 patients in Ghana was more than four times higher than Kenya - a difference that could be attributed to, among other things, an average of twelve days length of stay assumed in the Kenyan study as compared to twenty-one days in the case of Ghana.

Our study showed that once a patient moved from home management to the treatment centre, the average cost of treatment increased by about 20-folds (US\$282 to US\$5,707). A similar costing study found that, in the context of Kenya, home-based care for COVID-19 cases was nine times cheaper than institutional base care scenarios with overheads, staff costs and PPEs being the drivers of the costs difference.

Meanwhile, the present study found that once a patient's condition deteriorated from mild to moderate, the cost escalated by 155% but the cost-mix shifted from 71% overheads in the case of patients with mild symptoms to 50% for cases with moderate symptoms, while the cost of in-patient care increased from 22% to 35%. Similarly, deteriorating from moderate to severe resulted in more than doubling the costs of treatment but only a marginal difference of 15.2% was found between the cost of patients with severe symptoms versus those that were critically ill.

The current study also estimates that in institutionally managed patients, overhead cost accounted for 63% to 71% of the overall cost of treatment of which 81% were attributable to PPEs, 28% for accommodation and utilities, and 3% for transportation. The cost of drugs accounted for just up to 1% in institutionally managed patients and 5% for patients managed at home. These findings, however, contrasted sharply with those of the Chinese study in which the cost of drugs was observed to be the major cost driver, accounting for 45.1%, of the overall mean (10).

From a cost containment perspective, these findings underline the need for early detection and effective treatment of COVID-19 cases, preferably at home, before any chance of deterioration to the next worst form of the disease state. The few studies that have reported on the cost of treating COVID-19 also collaborate these findings in the context of Kenya, and broadly low- and middle-income countries. Nevertheless, the substantial cost jumps also raise concerns if there was still room for efficiency gains in the resource use in the management of severe and critically ill patients that may accrue as better evidence on the management of COVID-19 evolves.

CONCLUSION

Cost savings could be made by early detection and effective treatment of COVID-19 cases, preferably at home, before any chance of deterioration to the next worst form of the disease state, thereby freeing up more resources for other aspects of the fight against the pandemic. Policy makers in Ghana should thus make it a top priority to intensify the early detection and case management of COVID-19 infections.

LIMITATIONS

This study has some inherent limitations that must be taken into account when using the same for policy or decision making. First, it is worth noting that the estimates reported in this paper are based on Ghana's COVID-19 Case Management Protocol up to June 2020, after which there have been some changes, which may impact the results if the estimates were to be updated in line with the new protocols.

Second, the future costs of treating COVID-19 cases could vary drastically depending on the emergence of new drugs and technology, and better risk stratification of patients. Based on

this, there is a need to continually update the estimation of the costs of COVID-19 case management as the evidence and treatment protocols evolve.

Finally, although every effort was made to use the prevailing market prices as unit costs for resources needed for COVID-19 treatment, volatile pricing resulting from the COVID-19 itself is one factor that could make these estimates quickly outdated. Also, hydroxychloroquine which was part of the treatment protocol was not available on the local market; hence its price was taken from international sources.

Nevertheless, this study, to the best of our knowledge, represents one of the first attempts to undertake bottom-up, point of care resource use data collection approach to estimating the costs of managing COVID-19 cases in Ghana and Africa. The results of this study, although imprecise, provide a reasonable basis for estimating the overall cost of the response and for planning resource needs for fighting the ongoing COVID-19 pandemic in Ghana and other similar contexts.

LIST OF ABBREVIATIONS

WHO: World Health Organization

DECLARATIONS

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Availability of data and materials: The datasets supporting our conclusions are publicly available and will be provided upon request.

Authors' contributions: HI and JAA are co-first authors. HI and JAA conceived the study and designed the tools for data collection. HI and EOM collected the data. SKA, VKL, EOM and JNO validated the data. HI, JAA and JNO led the initial drafting of the manuscript with substantial contribution from SKA, VKL and EOM. All authors reviewed and approved the final manuscript. JNO and SKA oversaw the overall quality assurance of the analysis and manuscript.

Ethics approval and consent to participate: The work is based on publicly available data and did not involve the use of human subjects or animals. No ethical approval was required.

Consent for publication: All authors have approved the manuscript for submission.

Competing interests: The authors declare that they have no competing interests.

Supplementary Tables S1 – S5: Resource Use and Unit Costs for various levels of severity of COVID-19

Table S1: Resource Use and Unit Costs for Critically ill cases of COVID-19

Resources	Quantity per day	Average Length of Stay in Hospital-isolation centre/duration of resource Use	Unit cost (GH¢)	Sub-Total (GH¢)	Source of Data
Overheads					
Patient transportation	2 times	1	734.00	734.00	GHS transport cost in + state transport fare out
Patient accommodation, feeding and utilities per in-patient day	Meals - 3 times per day	21	383.12	8,045.52	National Health Insurance Scheme (NHIS, 2016) - cerebral malaria as proxy
Personal Protective Equipment (PPEs) - Doctors	Doctor: 4 PPE per day per patient	21	400.00	33,600.00	Procurement invoices
Personal Protective Equipment (PPEs) - Nurses	Nurse: 6 PPE per day per patient	21	400.00	50,400.00	Procurement invoices
Investigations					
COVI-19 test	3 times per stay	1	367.25	1,101.75	Nugochi Memorial Institute for Medical Research
X-rays	Once per stay	1	60.00	60.00	University of Ghana Medical Centre (UGMC)
Full Blood Count	3 times per stay	1	12.04	36.12	NHIS (2016)
Computer Tomographic (CT) Scan	Two per stay	1	350.00	700.00	UGMC
Blood gases	3 times per stay	21	11.53	726.39	NHIS (2016)
Ultrasound scan (if pregnant)	Once per stay	1	28.29	28.29	NHIS (2016)
Electrocardiogram (ECG)	Once per stay (part of continuous monitoring)	1	7.74	-	NHIS (2016)
Chemistry (Liver Function Test, Renal Function Test, Electrolytes)	up to 8 times per stay	8	10.34	165.44	NHIS (2016)
Coagulation profile (Bleeding time, platelets, prothrombin time etc)	Once per stay	1	7.70	7.70	NHIS (2016)
Medications					
Vitamin C	1 gram per day	14	0.10	1.40	NHIS (2020)
Zinc	20 mg per day	10	0.10	1.00	NHIS (2020)
Hydroxychloroquine	200 mg 3X daily	10	2.14	64.20	
Azithromycin	500 mg daily	5	3.00	15.00	NHIS (2020)
Antibiotics - Ceftriaxone	2g daily	5	127.16	635.80	
Thrombolytics - Enoxaparin (Rx)	80mg daily	14	87.10	1,219.40	NHIS (2020)
In-patient care					
Oxygen	3,600 litres daily	14	10.00	3,360.00	Greater Accra Regional Hospital
Mechanical ventilation	GH¢ 450 per day; monitoring – Gh¢250; central line GH¢ 350 (every 14 days)	21	700.00	15,050.00	Greater Accra Regional Hospital
Logistics: Syringes, needles, etc	30 pieces per stay	1	55.00	55.00	Central Medical Stores (CMS)
Staff time					

Resources	Quantity per day	Average Length of Stay in Hospital-isolation centre/duration of resource Use	Unit cost (GH¢)	Sub-Total (GH¢)	Source of Data
General medical practitioner	Two hours per day	21	54.62	2,294.01	Fair Wages and Salaries Commission (FWSC), 2020
Medical Specialist	Four hours per day	21	71.53	6,008.42	FWSC, 2020
Professional Nurses (General)	Six hours per day	21	37.51	4,725.95	FWSC, 2020
Professional Nurses (Specialised)	Six hours per day	21	37.51	4,725.95	FWSC, 2020
Medical laboratory scientist/technician	3 hours per stay	1	36.44	109.32	FWSC, 2020
Radiographer/Diagnostic Technician	30 mins	1	36.44	18.22	FWSC, 2020
Clinical psychologists	1 hour per stay	1	36.44	36.44	FWSC, 2020
Physiotherapists	1 hour per stay	1	36.44	36.44	FWSC, 2020
Nutritionist/Dietician	1 hour per patient per stay	1	36.44	36.44	FWSC, 2020
Emergency Medical Technician	16 hours per stay	1	16.08	257.28	FWSC, 2020
Orderlies (cleaning of patient and staff areas)	Three hours per day per patient	21	9.85	620.54	FWSC, 2020
Pharmacist	Two hours per patient per entire stay	1	36.44	72.88	FWSC, 2020
Kitchen Staff	Two hours per patient per entire stay	1	9.36	18.72	FWSC, 2020
Administrative /Health Information Staff - Documentation	Two hours per patient per entire stay	1	23.87	47.74	FWSC, 2020
Security	Throughout	21	12.74	133.74	FWSC, 2020
				135,149.10	

Table S2: Resource Use and Unit Costs for Severe Cases of COVID-19

Resources	Quantity per day	Average Length of Stay in Hospital-isolation centre/duration of resource Use	Unit cost (GH¢)	Sub-Total (GH¢)	Source of Data
Overheads					
Patient transportation	2 times	1	734.00	734.00	GHS transport cost in + state transport fare out
Patient accommodation, feeding and utilities per in-patient day	Meals - 3 times per day	19	383.12	7,279.28	NHIS (2016)
Personal Protective Equipment (PPEs) - Doctors	Doctor: 4 PPEs per day per patient	19	400.00	30,400.00	Procurement invoices
Personal Protective Equipment (PPEs) - Nurses	Nurse: 6 PPEs per day per patient	19	400.00	45,600.00	Procurement invoices
Investigations					
COVI-19 test	3 times per stay	1	367.25	1,101.75	Nugochi Memorial Institute for Medical Research
X-rays	Once per stay	1	60.00	60.00	NHIS (2016)
Full Blood Count	Twice per stay	1	12.04	24.08	NHIS (2016)
Computer Tomographic (CT) Scan	Once per stay	1	350.00	350.00	NHIS (2016)
Blood gases			11.53	-	NHIS (2016)
Ultrasound scan (if pregnant)	Once per stay	1	28.29	28.29	NHIS (2016)
Electrocardiogram (ECG)	Once per stay	1	7.74	7.74	NHIS (2016)
Chemistry (Liver Function Test, Renal Function Test, Electrolytes)	Twice per stay	1	10.34	20.68	NHIS (2016)
Coagulation profile	Once per stay	1	7.70	7.70	NHIS (2016)
Medications					
Vitamin C	1 gram per day	14	0.10	1.40	NHIS (2020)
Zinc	20 mg per day	10	0.10	1.00	NHIS (2020)
Hydroxychloroquine	200 mg 3X daily	10	2.14	64.20	Open Source
Azythromycin	500 mg daily	5	3.00	15.00	NHIS (2020)
Antibiotics - Ceftriaxone	2g daily	5	127.16	635.80	NHIS (2020)
Thrombolytics - Enoxaparin (Rx)	80mg daily	5	87.10	435.50	NHIS (2020)
In-patient care					
Oxygen	3,600 liters daily	14	10.00	3,360.00	Greater Accra Regional Hospital
Mechanical ventilation	Based on need	14	700.00	9,800.00	Greater Accra Regional Hospital
Logistics: Syringes, needles, etc	30 pieces per stay	1	55.00	55.00	Central Medical Stores (CMS)
Staff time					
General medical practitioner	Two hours per day	19	54.62	2,075.53	FWSC, 2020
Medical Specialist (ISCO xxxx)	Four hours per day	19	71.53	5,436.19	FWSC, 2020
Professional Nurses (General)	Six hours per day	19	37.51	4,275.86	FWSC, 2020
Professional Nurses (Specialised)	Six hours per day	19	37.51	4,275.86	FWSC, 2020
Nursing Associate professionals/Auxiliary Nurses (ISCO 2222)			17.19	-	FWSC, 2020
Medical laboratory scientist/technician	3 hours per stay	1	36.44	109.32	FWSC, 2020
Radiographer/Diagnostic Technician	30 mins	1	36.44	18.22	FWSC, 2020

Resources	Quantity per day	Average Length of Stay in Hospital-isolation centre/duration of resource Use	Unit cost (GH¢)	Sub-Total (GH¢)	Source of Data
Clinical psychologists	1 hour per stay	1	36.44	36.44	FWSC, 2020
Physiotherapists	1 hour per stay	1	36.44	36.44	FWSC, 2020
Nutritionist/Dietician	1 hour per patient per stay	1	36.44	36.44	FWSC, 2020
Emergency Medical Technician	16 hours per stay	1	16.08	257.28	FWSC, 2020
Orderlies (cleaning of patient and staff areas)	Three hours per day per patient	19	9.85	561.44	FWSC, 2020
Pharmacist	Two hours per patient per entire stay	1	36.44	72.88	FWSC, 2020
Kitchen Staff	Two hours per patient per entire stay	1	9.36	18.72	FWSC, 2020
Administrative /Health Information Staff - Documentation	Two hours per patient per entire stay	1	23.87	47.74	FWSC, 2020
Security	Throughout	19	12.74	121.00	FWSC, 2020
				117,360.79	

Table S3: Resource Use and Unit Costs for Moderate Cases of COVID-19

Resources	Quantity per day	Average Length of Stay in Hospital-isolation centre/duration of resource Use	Unit cost (GH¢)	Sub-Total (GH¢)	Source of Data
Overheads					
Patient transportation	2 times	1	734.00	734.00	GHS transport cost in + state transport fare out
Patient accommodation, feeding and utilities per in-patient day	Meals - 3 times per day	19	383.12	7,279.28	NHIS (2016)
Personal Protective Equipment (PPEs) - Doctors	Doctor: 2 PPE per day per patient	19	400.00	15,200.00	Procurement invoices
Personal Protective Equipment (PPEs) - Nurses	Nurse: 3 PPE per day per patient	19	400.00	22,800.00	Procurement invoices
Investigations					
COVI-19 test	2 times per stay	2	367.25	1,469.00	Nugochi Memorial Institute for Medical Research
X-rays	Once per stay	1	60.00	60.00	University of Ghana Medical Centre (UGMC)
Full Blood Count	Twice per stay	2	12.04	48.16	NHIS (2016)
Computer Tomographic (CT) Scan	Once per stay	1	350.00	350.00	NHIS (2016)
Ultrasound scan (if pregnant)	Once per stay	1	28.29	28.29	NHIS (2016)
Electrocardiogram (ECG)	Once per stay	1	7.74	7.74	NHIS (2016)
Medications					
Vitamin C	1 gram per day	14	0.10	1.40	NHIS (2020)
Zinc	20 mg per day	10	0.10	1.00	NHIS (2020)
Hydroxychloroquine	200 mg 3X daily	10	2.14	64.20	Open Source
Azythromycin	500 mg daily	5	3.00	15.00	NHIS (2020)
Thrombolytics	40mg daily	5	87.10	435.50	NHIS (2020)
In-patient care					
Logistics: Syringes, needles, etc	30 pieces per stay	1	55.00	55.00	Central Medical Stores (CMS)
Staff time					
General medical practitioner	Two hours per day	19	54.62	2,075.53	FWSC, 2020
Medical Specialist	One hour per day	19	71.53	1,359.05	FWSC, 2020
Professional Nurses (General)	Three hours per day	19	37.51	2,137.93	FWSC, 2020
Professional Nurses (Specialised)	One hour per day	19	37.51	712.64	FWSC, 2020
Nursing Associate professionals/Auxiliary Nurses	Three hours per day	19	17.19	979.97	FWSC, 2020
Medical laboratory scientist/technician	3 hours per stay	1	36.44	109.32	FWSC, 2020
Radiographer/Diagnostic Technician	30 mins	1	36.44	18.22	FWSC, 2020
Clinical psychologists	1 hour per stay	1	36.44	36.44	FWSC, 2020
Physiotherapists	30 mins per stay	1	36.44	18.22	FWSC, 2020
Nutritionist/Dietician	1 hour per patient @ per stay	1	36.44	36.44	FWSC, 2020

Resources	Quantity per day	Average Length of Stay in Hospital-isolation centre/duration of resource Use	Unit cost (GH¢)	Sub-Total (GH¢)	Source of Data
Emergency Medical Technician	16 hours per stay	1	16.08	257.28	FWSC, 2020
Orderlies (cleaning of patient and staff areas)	Three hours per day per patient	19	9.85	561.44	FWSC, 2020
Pharmacist	Two hours per patient per entire stay	2	36.44	145.76	FWSC, 2020
Kitchen Staff	Two hours per patient per entire stay	19	9.36	355.70	FWSC, 2020
Administrative /Health Information Staff -Documentation	Two hours per patient per entire stay	1	23.87	47.74	FWSC, 2020
Security	Throughout	19	12.74	121.00	FWSC, 2020
				57,521.25	

Table S4: Resource Use and Unit Costs for Mild/Asymptomatic Cases of COVID-19 (at hospitals or isolation centers)

Resources	Quantity per day	Quantity per day (calc)	Average Length of Stay in Hospital-isolation centre/duration of resource Use	Unit cost (GH¢)	Sub-Total (GH¢)	Source of Data
Overheads						
Patient transportation	2 times	1	1	734.00	734.00	GHS transport cost in + state transport fare out
Patient accommodation, feeding and utilities per in-patient day	Meals @3 times per day	1	19	383.12	7,279.28	NHIS (2016)
Personal Protective Equipment (PPEs) - Doctors	Doctor: 1 PPE per day per patient	1	19	400.00	7,600.00	Procurement invoices
Personal Protective Equipment (PPEs) - Nurses	Nurse: 2 PPE per day per patient	2	19	400.00	15,200.00	Procurement invoices
Investigations						
COVI-19 test	2 times per stay	2	1	367.25	734.50	Nugochi Memorial Institute for Medical Research
X-rays	Once per stay	1	1	60.00	60.00	University of Ghana Medical Centre (UGMC)
Full Blood Count	Twice per stay	2	1	12.04	24.08	NHIS (2016)
Ultrasound scan (if pregnant)	Once per stay	1	1	28.29	28.29	NHIS (2016)
Medications						
Vitamin C	1 gram per day	1	14	0.10	1.40	NHIS (2020)
Zinc	20 mg per day	1	10	0.10	1.00	NHIS (2020)
Hydroxychloroquine	300 mg 3X daily	3	10	2.14	64.20	Open Source
Azythromycin	500 mg daily	1	5	3.00	15.00	NHIS (2020)
In-patient care						
Staff time						
General medical practitioner	One hour per day	1	1	54.62	54.62	FWSC, 2020
Professional Nurses (General)	Two hours per day	2	2	37.51	150.03	FWSC, 2020
Professional Nurses (Specialised)	One hour per day	1	1	37.51	37.51	FWSC, 2020
Medical laboratory scientist/technician	2 hours per stay	2	1	36.44	72.88	FWSC, 2020
Radiographer/Diagnostic Technician	30 mins	0.5	1	36.44	18.22	FWSC, 2020
Clinical psychologists	1 hour per stay	1	1	36.44	36.44	FWSC, 2020
Physiotherapists		0	0	36.44	-	FWSC, 2020
Nutritionist/Dietician	30 mins per patient @ per stay	0.5	1	36.44	18.22	FWSC, 2020
Emergency Medical Technician	16 hours per stay	16	1	16.08	257.28	FWSC, 2020

Resources	Quantity per day	Quantity per day (calc)	Average Length of Stay in Hospital-isolation centre/duration of resource Use	Unit cost (GH¢)	Sub-Total (GH¢)	Source of Data
Orderlies (cleaning of patient and staff areas)	Two hours per day per patient	2	19	9.85	374.29	FWSC, 2020
Pharmacist	One hour per patient per entire stay	1	1	36.44	36.44	FWSC, 2020
Kitchen Staff	Two hours per patient per entire stay	2	1	9.36	18.72	FWSC, 2020
Administrative /Health Information Staff - Documentation	Two hours per patient per entire stay	2	1	23.87	47.74	FWSC, 2020
Security	Throughout	0.5	19	12.74	121.00	FWSC, 2020
					32,985.14	

Table S5: Resource Use and Unit Costs for home-based management of mild/asymptomatic cases

Resources	Quantity per day	Average Length of Stay in Hospital-isolation centre/duration of resource Use	Unit cost (GH¢)	Sub-Total (GH¢)	Source of Data
Overheads					
Thermometre	1	1	100.00	100.00	Procurement invoices
Investigations					
COVI-19 test	2 times per stay	1	367.25	734.50	Nugochi Memorial Institute for Medical Research
Ultrasound scan (if pregnant)	Once per stay	1	28.29	28.29	University of Ghana Medical Centre (UGMC)
Medications					
Vitamin C	1 gram per day	14	0.10	1.40	NHIS (2020)
Zinc	20 mg per day	10	0.10	1.00	NHIS (2020)
Hydroxychloroquine	300 mg 3X daily	10	2.14	64.20	Open Source
Azythromycin	500 mg daily	5	3.00	15.00	NHIS (2020)
In-patient care					
Staff time					
General medical practitioner	16 Minutes per day	19	54.62	280.20	FWSC, 2020
Professional Nurses (General)	16 Minutes per day	19	37.51	192.41	FWSC, 2020
Medical laboratory scientist/technician	2 hours per stay	1	36.44	72.88	FWSC, 2020
Clinical psychologists	1 hour per stay	1	36.44	36.44	FWSC, 2020
Nutritionist/Dietician	30 minutes per patient per stay	1	36.44	18.22	FWSC, 2020
Pharmacist	1 hour per patient per entire stay	1	36.44	36.44	FWSC, 2020
Administrative /Health Information Staff -Documentation	2 hours per patient per entire stay	1	23.87	47.74	FWSC, 2020
				1,628.72	

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