Phyu Win Thant\textsuperscript{1}, Khin Thu Htet\textsuperscript{1}, Wit Ye Win\textsuperscript{1}, Ye Min Htwe\textsuperscript{1}, Thant Sin Htoo\textsuperscript{1}

1) Phyu Win Thant  
MB.,B.S(YGN), MPH(YGN), GCertEc(Aus), MHlthEcPol(Aus)  
Assistant Director, Minister Office, Ministry of Health and Sports, Nay Pyi Taw, Myanmar  
Email: phyuwinthant@mohs.gov.mm

2) Khin Thu Htet  
MB.,B.S(YGN), MPH(YGN)  
Assistant Director, Minister Office, Ministry of Health and Sports, Nay Pyi Taw, Myanmar  
Email: khinthuhtet@mohs.gov.mm

3) Wit Ye Win  
MB.,B.S(YGN), MPH(YGN)  
Assistant Director, Minister Office, Ministry of Health and Sports, Nay Pyi Taw, Myanmar  
Email: wityewin@mohs.gov.mm

4) Ye Min Htwe  
MB.,B.S(YGN), MPH(YGN), Master of International Health & Master of Health Administration(Aus)  
Deputy Director, Minister Office, Ministry of Health and Sports, Nay Pyi Taw, Myanmar  
Email: yeminhtwe@mohs.gov.mm

5) Thant Sin Htoo  
MB.,B.S(YGN), MSc(Health Economics)(Thailand)  
Director, Minister Office, Ministry of Health and Sports, Nay Pyi Taw, Myanmar  
Email: thantsinhtoo@mohs.gov.mm

Correspondence to : Phyu Win Thant  
MB.,B.S, MPH, GCertEc, MHlthEcPol  
Assistant Director, Minister Office, Ministry of Health and Sports, Nay Pyi Taw, Myanmar  
(+95 95133250, phyuwinthant@mohs.gov.mm)
Abstract

Objective This study aims to estimate the cost of clinical management of COVID-19 infected patients based on their severity by exploring the resources used in care provision in Myanmar.

Methods: A multicenter retrospective cost analysis of COVID-19 patients treated was performed using the micro-costing approach from the perspective of the health system. It covered two cost components, namely Direct and Indirect cost of treating a patient. Input data and their quantities were obtained from COVID-19 Standard Treatment Guidelines of Ministry of Health and Sports, and administrative and financial record of resource utilization of three designated health facilities in Yangon Region. Valuation of these resources was based on the price list from the Procurement Section of the Ministry.

Results: This study estimated the unit cost of clinical management of COVID-19 infected patients with no symptom to be 953,552 MMK(717 USD), with mild-moderate symptoms to be 1,155,222 MMK(869 USD) and with severe-critically ill conditions to be 5,705,052 MMK(4290 USD). Average cost for a patient per day was 86,687 MMK(65 USD) for asymptomatic patients, 105,020 MMK(79 USD) for mild-moderate patients and 283,252 MMK(214 USD) for severe-critically ill patients. Since the first case detected till December 31, 2020, COVID-19 clinical management cost was accounted for 139 Billion MMK (104 million USD) for total 124630 confirmed cases.

Conclusions: The result of this study indicates that the COVID-19 Pandemic leads Myanmar Health System to incur the significant health care expenses. Timely implementation of the sustainable, affordable and efficient policy for COVID-19 responses is of utmost important for every nation especially in this situation of Pandemic. Specifically, the study results should be of value for strategic planning, for future economic evaluations of different policy interventions, and to contribute healthcare policy recommendations by analyzing the current cost of health care system and preparing for the potential state of COVID-19 infection.
Cost Estimates of COVID-19 Clinical Management in Myanmar

*Key Words:* Direct Costs, Indirect Costs, COVID-19, Pandemic
Introduction

On Jan 30, 2020, World Health Organization (WHO) declared the novel coronavirus outbreak a Public Health Emergency of International Concern, later formally identified as Coronavirus Disease 2019 (COVID-19). On March 11, 2020, it was declared as a pandemic. The declaration advised the member states to prepare for containment and prevention of onward spread of the virus.[1] With its advice, Myanmar has established National-Level Central Committee on Prevention, Control and Treatment of COVID-19 on March 13, 2020, chaired by the State Counsellor, for effective response to the pandemic. The virus was confirmed to have reached Myanmar on March 23, 2020. Following the detection of the first case of COVID-19, the Government of Myanmar has stepped up to meet the challenges of COVID-19 by increasing testing and treatment capacity for COVID-19; providing quarantine facilities; and adding general and ICU bed capacity and developing the COVID centers to isolate and treat the patients with diseases while safeguarding the health of other patients and health care workers.[2]

In Myanmar, all COVID-19 infected patients have been treated in the public hospitals under the Ministry of Health and Sports (MoHS) throughout the country. In Yangon which is the most populated city of the country, three main health facilities have primarily designated for caring the COVID-19 patients, namely Waibargi Specialist Hospital (90 beds), South Okkalapa Specialist Hospital (80 beds) and Phaung Gyi COVID-19 Treatment Center (1,200 beds). Although there were only 374 cases and six deaths in the first wave, Myanmar has seen a dramatic rise in the number of cases in the second wave that has started on August 16, 2021. Yangon has become a major epicenter in the second wave and deaths have tripled and cases have risen by more than 700%. To reinforce the service provision, four additional temporary facilities with a capacity of about 4,050 beds in total across the Yangon Region host and treat less severe COVID-19 cases. [2,3]
Cost Estimates of COVID-19 Clinical Management in Myanmar

There are disastrous resource challenges for health systems of the countries around the world in light of the COVID-19 pandemic. The uncertainty of the pandemic duration alerts the needs to estimate the cost of treating the infected patients. Better evidence on the resources required would be instrumental not only to the clinicians and researchers, but also to policy makers and health planners in Health systems. This study aims to estimate the cost of clinical management of COVID-19 infected patients based on their severity by exploring the resources used in health care provision in Myanmar.

Methodology

Figure 1: Conceptual Framework

**Direct Cost for each patient**
- Human Resource (Patient Care Personnel Time)
- Drugs and Medical Supplies
- ICU Care and Oxygen therapy
- Lab tests & Imaging

**Indirect Cost for each patient**
- Overhead personnel time
- Non-medical equipment
- Operation Cost
- General Supplies

Unit cost of treating a COVID-19 Infected Patient
- Asymptomatic
- Mild-Moderate
- Severe/ Critically Ill

Study Design

A multicenter retrospective cost analysis of COVID-19 patients treated was implemented using the micro-costing approach from the perspective of the health system. The costs that were included in this exercise were mentioned in figure 1. It covered two cost components, namely direct and
Cost Estimates of COVID-19 Clinical Management in Myanmar

indirect cost. Direct costs were the costs that are directly attributable to patient care. It involved the cost of health workers that spent treating the patient, along with the entire test performed, drugs and medical supplies used including Personal Protective Equipment (PPE). The value of each of these resources (personnel time, tests, drugs, medical supplies) was identified and multiplied by the resource volume to calculate the total cost of the resources the patient directly consumed. Indirect costs, which were also called overheads, were the costs that were not directly related to the care. It included the costs of non-medical supplies such as furniture, office materials, cost of human resources who were working in Admin or Management roles, and the operation costs of these facilities such as electricity, water, etc.[4] These overheads were estimated and allocated to the patients by averaging the cost of resource used to provide services to a patient. Patient unit costs were presented as an average cost per patient for one episode of illness and unit cost per patient day. The study was conducted by following economic principles and involved collection of detailed resource-used information, particularly the quantity and unit costs of all resources used along each individual patient’s treatment pathway in three experienced and active COVID-19 designated hospital and centers. Land and building costs were not covered in this study due to different nature of the included study sites in origin and difficult to collect the data virtually. We obtained data on inputs and their quantities from the reports of three health facilities.

Clinical Management

Department of Medical Service under MoHS, Myanmar, has regularly updated Clinical Management Guidelines for COVID-19, as stated by WHO and country situation. During the study period, the most update guideline was released on August 25, 2020 and the study followed this guideline. As mentioned by these guidelines, COVID-19 disease severity can be classed as follows:
1) Asymptomatic or Pre-symptomatic Infection

2) Mild disease

• Symptomatic patients meeting the case definition for COVID-19 without evidence of viral pneumonia or hypoxia

3) Moderate disease/Pneumonia

• Adolescent or adult with clinical signs of pneumonia (fever, cough, dyspnoea, fast breathing)

4) Severe disease/Severe pneumonia

• Adolescent or adult with clinical signs of pneumonia (fever, cough, dyspnea, fast breathing) plus one of the following: respiratory rate > 30 breaths/min; severe respiratory distress; or SpO2 <93% on room air.

Discharge criteria for COVID-19 confirmed patients were referred to the guidelines from the Ministry as of October 10, 2020. This guideline mentioned:

I. For symptomatic COVID-19 confirmed patients:

(a) Patients with mild or moderate Illness who are not severely immunocompromised

• 10 days after onset of symptoms, plus at least 1 additional day without symptoms (including without fever with no antipyretics and without respiratory symptoms and other COVID-19 symptoms) provided that history of onset of symptoms is reliable

• If the history of onset of symptoms is not reliable, at least 11 days is recommended to stay in hospital.

(b) Patients with severe to critical illness or who are severely immunocompromised

• 10 days after onset of symptoms, plus at least 4 additional days without symptoms (including without fever with no antipyretics and without respiratory symptoms and other COVID-19 symptoms)
At least 20 days is recommended to stay in hospital.

II. For asymptomatic COVID-19 confirmed patients:

- 10 days after taking swab with positive test for SARS-CoV-2 [2]

Study sites

This study selected the one designated hospital and two newly established centers for COVID-19 in Yangon Region, namely Waibargi Specialist Hospital, Phaunggyi COVID-19 Treatment Center and the COVID center (Thuwana). Waibargi Specialist Hospital is the foremost and significant specialist hospital in Myanmar that previously treated the infectious diseases such as HIV, Multi-drug resistant TB, etc. In the COVID-19 pandemic era, it is the first designated hospital to treat the COVID-19 cases in Yangon. As Yangon is the most populated city in Myanmar, the Yangon Region Government has established the Phaunggyi COVID-19 Treatment center by transforming the Central Institute of Civil Service into the Medical Center to solve the shortage of hospital beds and ICU care. It starts to receive COVID-19 Inpatient in September, 2010. Private donors have contributed enormously to set up this largest COVID-19 center in Myanmar. To combat the rapid surge of cases in Yangon, Thuwanna Stadium was also converted to a temporary hospital to treat COVID-19 patient with the main support of AYA foundation who is the owner of this stadium. Center Inpatient care of COVID-19 cases has also initiated in September, 2020.[2]

Data collection of Resource use

Use of the resources for the patients was counted since the arrival at hospital/center till discharge.

Cost Estimation

A health system costing perspective was adopted and the cost per patient was measured and valued in Myanmar Kyats(MMK) and US dollar in the currency rate of February 1, 2021 (1 USD =
1330 MMK). Staff salaries were calculated using the average salary for each rank of staff under MoHS, apart from Intensive care unit (ICU) care of the COVID Center (Thuwanna) as it has the private contracted Medical officers and nurses for ICU. In pandemic situation, volunteers were contributing significantly to operate the COVID-19 facilities. We applied the minimum wage rate of 4800 MMK (3.6 USD) per day as per 2018 Myanmar Minimum Wage Law. Unit costs of medicines, medical commodities and medical and non-medical equipment were acquired from the procurement division of MoHS. For some few items that were not available from them, the costs of these items were estimated using the market price. Costs of investigations and imaging were referred to the private cost in order to cover all the resources used for these investigations. For the cost of COVID-19 testing, we were referring to the unpublished survey results regarding cost analysis of selected quarantine site, swab taking and lab procedures, implemented by University of Public Health, MoHS. For the cost of the Convalescent Plasma, input data were received from National Blood Bank to estimate the cost for each plasma unit.

The cost of capital items including both medical and non-medical assets were estimated using the economic-based approach that covers both depreciation cost and opportunity cost of making the investment. The annualization factor was calculated based on useful life and discount rate. The discount rate, as recommend by WHO guide, was 3% for the base case and Useful life was taken as 5 years for capital items. Annual capital costs were applied instead of using original costs as the assets were depleting on a daily basis.

**Total Cost Calculation**

Total estimated cost was obtained by multiplying the unit costs of clinical management and the number of cases according to the severity. For estimating the number of patients based on the
Cost Estimates of COVID-19 Clinical Management in Myanmar

disease severity, Central Epidemiology Unit of Department of Public Health and Medical Care Division of Department of Medical Services provided the data. [10]

Data Entry and Analysis

Data on resource quantities and unit costs of the different cost components were processed and analyzed using a MS Excel spreadsheet.

Results

Basic characteristics of the study facilities

Table 1: Basic Characteristics of Study Facilities

|                     | Waibargi Specialist Hospital | Phaunggyi COVID-19 Treatment Center | Covid Center (Thuwana) |
|---------------------|-----------------------------|-------------------------------------|------------------------|
| Number of Available Beds | 90                          | 1220                                | 1000                   |
| Total Number of COVID-19 Patients (from the first case acceptance to 31st Dec, 2020) | 827                          | 5958                                | 8162                   |
| Total Number of ICU patients | 151                          | 368                                 | 712                    |
| Average Length of Stay | 20                           | 11                                  | 11                     |
| Number of deaths due to COVID-19 | 65                            | 346                                 | 184                    |

Table 1 describes the basic characteristics of the study facilities. Number of available beds of Waibargi Specialist Hospital was 90 beds while Phaunggyi COVID-19 Treatment center had 1200 beds and COVID Center(Thuwana) had 1000 beds. Waibargi Specialist center had accepted the first case of COVID-19 since March, 2020. The other two newly established centers had initiated their inpatient care in September, 2020. Up to December 31st, 2020, Waibargi Specialist Center had treated 827 COVID-19 infected cases, Phaunggyi Center had treated 5958 cases and Thuwanna
center had treated 8162 cases. Average length of stay (ALOS) for Waibargi was 20 days and ALOS for other 2 centers was around 11 days.

**Unit Cost of COVID-19 Clinical Management (Asymptomatic Patients)**

Table 2: Unit Cost of COVID-19 Case Management for Asymptomatic Patients

| Inputs | Unit Cost (MMK) | Unit Cost (USD) | Percentage of Total Cost |
|--------|-----------------|-----------------|-------------------------|
| **I. Total Direct Cost per patient** | | | |
| 1. Cost for Direct Contact Health Care Personnel per patient | 48,516 | 36 | 5% |
| 2. Cost for Medicine and Medical Commodities | 268,699 | 202 | 28% |
| 2.1. Cost for Medicine per patient | - | - | 0% |
| 2.2. Cost for Medical Commodities per patient (Masks, Gloves, Gowns, Hand sanititizer, etc.) | 58,985 | 44 | 6% |
| 2.3. PPE cost per patient | 189,103 | 142 | 20% |
| 2.4. Cost of Medical Equipment per patient (BP cuff, thermometer, glucometer, pulse oximeter, syringe pump, etc) | 20,610 | 15 | 2% |
| **3. Cost of investigations and Imaging** | | | 20% |
| 3.1. Cost for Lab investigations per patient (Non-Covid) (CP(auto), urea & electrolytes, Liver/Renal Function tests, etc) | - | - | 0% |
| 3.2. Cost for COVID-19 Test per patient | 188,512 | 142 | 20% |
| 3.3. Cost for Imaging per patient | - | - | 0% |
| **4. Cost for Oxygen therapy per patient** | | | 0% |
| **5. Cost for ICU care per patient (Medical Equipment)** | | | 0% |
| **II. Total Indirect Cost per Patient** | | | 47% |
| 1. Cost for Non-Medical Equipment per patient (Furniture, computers, generators, etc) | 26,156 | 20 | 3% |
| 2. Cost of General HR per patient (Admin staff, general workers, security, etc.) | 91,186 | 69 | 10% |
| 3. Cost of Center/Hospital Operation per patient (Electricity & Water bill, Maintenance, Meal cost, etc.) | 330,483 | 248 | 35% |
| **Total Cost per patient** | 447,825 | 337 | 47% |
| **(Direct + Indirect)** | | | 100% |
| **Cost per patient per day** | 86,687 | 65 | |
| **(Asymptomatic)** | | | |

Table-2 mentions the unit costs for treating the asymptomatic patients of COVID-19, which was composed of two types of unit – 1) per patient, and 2) per inpatient day. Unit cost for treating one
asymptomatic patient was 86,687 MMK (65 USD) from the time when he/she was admitted to the facility till discharged. Direct cost was accounted for 505,727 MMK (380 USD, 53% of total). Although there was no additional cost for medicine and non-COVID investigations, direct cost was mainly composed of expenses for medical commodities especially for the safety of the staff such as masks, gloves, gowns (58,985 MMK, 44 USD) and expenses for personal protective equipment (189,103, MMK, 142 USD). Total indirect cost per patient was 447,825 MMK (337 USD, 47%) which included costs for non-medical equipment (26,156 MMK, 20 USD, 3%), general staff contribution (91,186 MMK, 69 USD, 10%) and facility operation (330,483 MMK, 248 USD, 35%). Unit cost per inpatient day was 86,687 MMK (65 USD).

**Unit Cost of COVID-19 Clinical Management (Mild-Moderate Patients)**

*Table 3:* Unit Cost of COVID-19 Case Management for Mild/Moderate Patients

| Inputs                                                                 | Unit Cost (MMK) | Unit Cost (USD) | Percentage of Total Cost |
|------------------------------------------------------------------------|-----------------|-----------------|--------------------------|
| I. Total Direct Cost per patient                                       | 683,315         | 514             | 59%                      |
| 1. Cost for Direct Contact Health Care Personnel per patient           | 51,928          | 39              | 4%                       |
| 2. Cost for Medicine and Medical Commodities                           | 270,145         | 203             | 23%                      |
| 2.1. Cost for Medicine per patient                                     | 1,446           | 1               | 0%                       |
| 2.2. Cost for Medical Commodities per patient (Masks, Gloves, Gowns, Hand sanstitzer, etc.) | 58,985 | 44 | 5% |
| 2.3. PPE cost per patient                                              | 189,103         | 142             | 16%                      |
| 2.4. Cost of Medical Equipment per patient (BP cuff, thermometer, glucometer, pulse oximeter, syringe pump, etc.) | 20,610 | 15 | 2% |
| 3. Cost of investigations and Imaging                                  | 347,512         | 261             | 30%                      |
| 3.1. Cost for Lab investigations per patient (Non-Covid) (CP(auto), urea &electrolytes, Liver/Renal Function tests, etc.) | 131,000 | 98 | 11% |
| 3.2. Cost for COVID-19 Test per patient                                | 188,512         | 142             | 16%                      |
| 3.3. Cost for Imaging per patient                                      | 28,000          | 21              | 2%                       |
| 4. Cost for Oxygen therapy per patient                                 | 13,730          | 10              | 1%                       |
| 5. Cost for ICU care per patient (Medical Equipment)                   | -               | -               | 0%                       |
II. Total Indirect Cost per Patient

1. Cost for Non-Medical Equipment per patient (Furniture, computers, generators, etc.)  
   26,156  20  2%
2. Cost of General HR per patient (Admin staff, general workers, security, etc.)  
   91,186  69  8%
3. Cost of Center/Hospital Operation per patient (Electricity & Water bill, Maintenance, Meal cost, etc.)  
   354,565  267  31%

Total Cost (Direct + Indirect)  
1,155,222  869  100%

Cost per patient per day (Mild-Moderate)  
105,020  79

Table 3 outlines the unit cost of COVID-19 clinical management for a patient with mild-moderate symptoms. There was a minor cost difference in the management of asymptomatic patients and patients with mild to moderate disease. The difference was due to medication for symptomatic treatment and Non-COVID investigations according to the clinical guidelines. For this kind of patient, cost of facility operation cost (354,565 MMK, 267 USD, 31%) made up the largest share, followed by the cost of PPE (189,103 MMK, 142 USD, 16%) and COVID-19 testing (189,103 MMK, 142 USD, 16%). Average unit cost per mild-moderate patient was 1,155,222 MMK (869 USD) and average cost per patient day was 105,020 MMK (79 USD).

Unit Cost of COVID-19 Clinical Management (Severe-Critically Ill Patients)

Table 4: Unit Cost of COVID-19 Case Management for Severe/Critically Ill Patients

| Inputs                                      | Unit Cost (MMK) | Unit Cost (USD) | Percentage of Total Cost |
|----------------------------------------------|-----------------|-----------------|--------------------------|
| I. Total Direct Cost per patient             | 5,122,004       | 3,851           | 90%                      |
| 1. Cost for Direct Contact Health Care Personnel per patient | 1,161,548       | 873             | 20%                      |
| 2. Cost for Medicine and Medical Commodities | 1,616,595       | 1,215           | 28%                      |
| 2.1. Cost for Medicine per patient           | 1,347,896       | 1,013           | 24%                      |
| 2.2. Cost for Medical Commodities per patient|                 |                 |                          |
### Cost Estimates of COVID-19 Clinical Management in Myanmar

| Cost Category                                                                 | Unit Cost (MMK) | Percentage | Description                                                                 |
|------------------------------------------------------------------------------|-----------------|------------|-----------------------------------------------------------------------------|
| 2.2. Cost for Medical Commodities per patient (Masks, Gloves, Gowns, Hand sensitizer, etc.) | 58,985          | 1%         |                                                                             |
| 2.3. PPE cost per patient                                                    | 189,103         | 3%         |                                                                             |
| 2.4. Cost of Medical Equipment per patient (BP cuff, thermometer, glucometer, pulse oximeter, syringe pump, etc.) | 20,610          | 0%         |                                                                             |
| 3. Cost of investigations and Imaging                                        | 837,812         | 15%        |                                                                             |
| 3.1. Cost for Lab investigations per patient (Non-Covid) (CP (auto), urea & electrolytes, Liver/Renal Function tests, etc.) | 621,300         | 11%        |                                                                             |
| 3.2. Cost for COVID-19 Test per patient                                      | 188,512         | 3%         |                                                                             |
| 3.3. Cost for Imaging per patient                                            | 28,000          | 0%         |                                                                             |
| 4. Cost for Oxygen therapy per patient                                       | 531,004         | 9%         |                                                                             |
| 5. Cost for ICU care per patient (Medical Equipment)                         | 799,760         | 14%        |                                                                             |
| II. Total Indirect Cost per Patient                                          | 583,048         | 10%        |                                                                             |
| 1. Cost for Non-Medical Equipment per patient (Furniture, computers, generators, etc.) | 26,156          | 0%         |                                                                             |
| 2. Cost of General HR per patient (Admin staff, general workers, security, etc.) | 91,186          | 2%         |                                                                             |
| 3. Cost of Center/Hospital Operation per patient (Electricity & Water bill, Maintenance, Meal cost, etc.) | 465,706         | 8%         |                                                                             |
| **Total Cost** (Direct + Indirect)                                           | 5,705,052       | 100%       |                                                                             |
| **Cost per patient per day** (Severe-Critically Ill)**                        | 285,253         | 214        |                                                                             |

Table 4 presents the unit cost for clinical management of COVID-19 with severe-critically ill symptoms. Unit cost for treating this type of patient was estimated to be 5,705,052MMK (4290 USD) which was more than five times costly than asymptomatic patients. Cost of medication was the main contributor of the total cost and made 24% of the total (1,347,896 MMK, 1013 USD). Other cost drivers were direct contact health care personnel cost per patient (20%, 1,161,548 MMK, 873 USD) and ICU Care (14%, 799,760MMK, 601 USD).
Total Estimated Costs of Clinical Management of COVID-19 infected patients

Table 5: Total Cost of Clinical Management of COVID-19 infected patients till 31st December, 2020

| Items                                         | Unit Cost (MMK) | Unit Cost (USD) | No of Patients (March 1st, 2020-31st Dec, 2020) | Total (MMK)        | Total (USD)        |
|------------------------------------------------|-----------------|-----------------|-----------------------------------------------|-------------------|-------------------|
| Cost for Asymptomatic Patients                | 953,552         | 717             | 47,359                                        | 45,159,648,614    | 33,954,623        |
| Cost for Mild-Moderate Patients               | 1,155,222       | 869             | 76,169                                        | 87,991,633,466    | 66,159,123        |
| Cost for Severe to Critically ill Patients    | 5,705,052       | 4,290           | 1,102                                         | 6,286,967,304     | 4,727,043         |
| Total Cost (From March 1st, 2020 to December 31st, 2020) |                |                 |                                               | 139,438,249,370   | 104,840,789       |
| Total Number of Confirmed Cases (From March 1st, 2020 to December 31st, 2020) |                |                 |                                               | 124,630           |                   |

On December 31, 2020, Myanmar has recorded 124,630 confirmed cases with 47,379 asymptomatic patients, 76,169 patients with mild-moderate symptoms and 1,102 patients with severe-critically ill patients. Clinical management cost for these patients accounted for 139,438,249,370 MMK (104,840,789 USD) in total. It was described in table 5.

Discussion

This report presents the evidence on the costs of COVID-19 Clinical Management in Myanmar. Specifically, it estimated unit cost for the treatment of the COVID-19 infected patients with no symptoms, mild-moderate symptoms and severe-critically ill symptoms. The findings indicated that COVID-19 treatment costs were extensive for all three categories of patients; cost for severe to critically ill patients were nearly five times higher than the other two categories. Severe-critically ill patients usually needed intensive care treatment, expensive anti-viral and oxygen therapy as well
as more specialist human resources such as anesthetists, ICU nurse, etc. Human resource problem was the most challenging issue as it could not be solved immediately. As the specialty trainings especially for ICU care are considerably limited in the Ministry, Thuwanna COVID Center has been solving this issue with the contracted service with the private providers for ICU care. This caused the direct HR cost much higher than in Thwanna center than the other two, making the average direct HR cost to be the second largest cost driver of the total cost. To avoid the inefficient use of ICU care, Myanmar needs to strengthen the effective service provision of ICU of hospitals.[11] Similar results could be found in the study of Barasa. et al. in Kenya. They calculated the expenses for treating asymptomatic patients at health facilities which was 843.51 USD, 843.75 USD for mild/moderate patients, 1429 USD for severe patients, and 6753 USD for critical COVID-19 disease. [12]

Our study also analyzed the total cost by categorizing into the direct and the indirect cost for treating the cost of COVID-19 infected patients from health system perspective. Direct cost measured the resource used directly for services while indirect cost measures overhead use. For asymptomatic or mild-moderate patients, there was no significant difference between the percentage share of total cost between direct and indirect cost. For asymptomatic patients, Direct cost was composed of 2 main cost items which are PPE cost(20%) and COVID-19 Testing (20%). Although health care workers did not need to give much time for caring asymptomatic patients, PPEs were still required for taking care of them. According to Barasa.E, et.al study, Kenya health care policy applied home based care for asymptomatic or mild-moderate patients and it could be seen that cost for health care staff and PPE were much reduced for home based care, while compared to these costs that were incurred for asymptomatic patients who were treated at hospitals or isolation centers.[12] For severe and critically ill patients, our study mentioned that direct cost made 90% of total cost and overhead cost for treating them made only a small portion
as care for such kind of patients required the significant workload of health care staff including specialists (1,616,595 MMK, 1215 USD per patient), expensive drugs (58,985MMK, 44 USD per patient), PPE(189,103 MMK, 142 USD), Investigations (837,812 MMK, 630 USD), and cost for ICU care and oxygen therapy (1,303,764MMK, 1000 USD). In Ghaffari Darab et al., study in Iran, they estimated the direct medical and indirect costs of treating the COVID-19 from a societal perspective between March and July 2020. Mean cost for ICU care for a severe patient is 4384 USD, Drugs and supplies cost 4313 USD, Health care professional cost for 734 USD, and investigations for 572 USD.[13]

In this study, we also estimated the total cost for treating all COVID-19 infected patients starting from the first case to 124630 cases within 10-month period (March-December 2020). It was found that total 139 trillion MMK (104 million USD) has been incurred during that period for treating them. This amount was equal to 3% of total current health expenditure in 2018 according to Myanmar National Health Account (2016-2018). [14] Since from the first case detected in March, 2020 till December 31, 2020, Myanmar Government has given care to all infected patients regardless of the severity of symptoms and affordability without taking any charge, providing all supply including accommodation, food, etc. As there is no proper health insurance system in Myanmar, funding for COVID-19 prevention and response has been complemented by the government supplementary budget, general reserve fund from reallocation of line ministries [15], public donation and international aids. In the course of financial sustainability, COVID-19 expenses should be closely tracked and used for policy planning and effective implementation. It also should be aware that this figure still did not include treatment of comorbidities and the expenses for implementation of infection control policies of COVID-19 such as contact tracing, testing, quarantine, etc. Around the world, COVID-19 pandemic has affected health care budget of the
countries. In China, it was found that total estimated health care cost for Covid-19 was 0.62 billion USD from Jan 2020 to March 2020.[16] In a modelling study for 73 low income and middle income countries, it has been estimated that 52.45 USD billion would be incurred over 4 weeks of Pandemic and among them, 54% was for case management, 21% for maintaining essential services and 14% for rapid response and case investigations.[17] Bartsch et al., estimated that 654 billion USD would be required for direct medical cost if 80 percent of the US population were to get infected and 163 billion would be required 20 percent were to get infected. [18] These two studies have forecasted the potential cost for health care for managing COVID-19 and highlighted the burden of the health care system and need for preparation of additional resources and financial support. In the case of not being able to estimate which time COVID-19 infection can be terminated, this high case management cost put the pressure to the ruling government especially the countries with limited health care budget and the sustainable way should be formulated for the long run. Otherwise, fiscal strain will be occurred both on the government and the public. Policy for testing and admission should be reviewed and updated in congruence with the infectivity rate as well as potential economic impact of different policy options in the country.

**Strengths and Limitation**

This study had a number of strengths. As it applied a bottom-up micro-costing, it involved the detail identification and quantification of resources that were used in clinical management of COVID-19 since admission till discharge. In addition, it covered three health facilities with different nature, composing one public designated hospital and two public-private temporary facilities. This allowed potential for generalization across wider healthcare economies. There were some limitations of this study that should be recognized. This study is based on normative costing based on Standard Treatment Guidelines of Ministry to identify and measure the resources used. But, in reality, there
may be some variations in practices across the different hospitals and across the countries. Further studies are recommended to get the costs of the health facilities at State/Region level and Township level to get the complete picture of financial implications of different policy options. Although there may be potential accuracy issues of the data presented in this study due to the time constraint and pandemic situation, an extensive effort was made to identify all relevant data about each designated health centers, capture all valid cost items and ensure the validity. In spite of these limitations, it should be highlighted that this is the initial effort to point out the clinical management cost of COVID-19 in Myanmar.

**Conclusion**

The result of this study indicates that the COVID-19 Pandemic leads Myanmar Health System to incur the devastating expenses of health care provision. Timely implementation of the sustainable, affordable and efficient policy for COVID-19 responses is of utmost important for every nation especially in this situation of Pandemic. Specifically, the study results should be of value for strategic planning, for future economic evaluations of different policy interventions, and to contribute healthcare policy recommendations by analyzing the current cost of health care system and preparing for the potential state of COVID-19 infection.

**References**

1. World Health Organization. "Timeline: WHO’s COVID-19 Response." [cited: 10th Feb 2020] Available at: https://www.who.int/emergencies/diseases/novel-coronavirus-2019/interactive-timeline#!

2. Ministry of Health and Sports. "COVID-19 Surveillance News." Ministry of Health and Sports, Nay Pyi Taw. [cited: 11 Feb 2021] Available at: https://www.mohs.gov.mm/ Accessed: 11 Feb 2021.

3. Angel H, Thura M, Grafilo J. "A Month on, Virus Deaths Triple, Infections Soar 700% in Myanmar." The Myanmar Times, 2020: Available at https://www.mmtimes.com/news/month-virus-deaths-triple-infections-soar-700-myanmar.html [cited: 11 Feb 2021].
4. Ozaltin, A., and C. Cashin, eds. "Costing of Health Services for Provider Payment: A Practical Manual Based on Country Costing Challenges, Trade-offs, and Solutions." Joint Learning Network for Universal Health Coverage, 2014.

5. Central Bank of Bank of Myanmar. Reference Exchange Rate. Available at https://forex.cbm.gov.mm/index.php/fxrate. Accessed on 11 Feb 2021, 2021.

6. Edejer TT-T, Baltussen R, Adam T. et al. (2009). *Making Choices in Health: WHO Guide to Cost-effectiveness Analysis*. Geneva: World Health Organization.

7. Drummond M, O’Brien BJ, Stoddart GL & Torrance GW. Method for the Economic Evaluation of Health Care Programmes. Oxford: Oxford University Press, 1997.

8. Creese A, Parker D. Cost Analysis in Primary Health Care: A Training Manual for Programme Managers. Geneva: World Health Organization, 2000.

9. Riewpaiboon A, Malaroje S, Kongsawatt S. Effect of costing methods on unit cost of hospital medical services. Tropical Medicine & International Health. 2007 Apr;12(4):554-63.

10. CEU, Central Epidemiology Unit. Coronavirus Disease 2019 (COVID-19). Situation Report-262, Nay Pyi Taw: Ministry of Health and Sports, 2020.

11. Than, T.M., Saw, Y.M., Khaing, M. et al. "Unit cost of healthcare services at 200-bed public hospitals in Myanmar: what plays an important role of hospital budgeting?." BMC Health Serv Res 17,, 2017: 669. https://doi.org/10.1186/s12913-017-2619-z.

12. Edwine Barasa, Agnela Kairu, Wangari Nganga, et.al. "Examining Unit Costs for COVID-19 Case Management in Kenya." mdeRxiv preprint, 2020.

13. Darab MG, Keshavarz K, Sadeghi E, et.al, "The economic burden of coronavirus disease 2019 (COVID-19): evidence from Iran.” BMC Health Services Research. 2021 Dec;21(1):1-7.

14. Ministry of Health and Sports. Myanmar National Health Accounts 2016-2018. Nay Pyi Taw, Myanmar: Ministry of Health and Sports, 2020.

15. World Bank. Myanmar Economic Monitor, December 2020: Coping with COVID-19.

16. Jin, H., Wang, H., Li, X., et al. The Economic Impact of COVID-19, China, January-March, 2020: a cost-of-illness study. Bull WORl Health Organization, 2021.

17. Edejer, T. T., Hanssen, O., Mirelman, A., et.al. "Projected health-care resource needs for an effective response to COVID-19 in 73 low-income and middle-income countries: a modelling study." The Lancet Global Health 8, no. 11, 2020: e1372-e1379.

18. 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(6):927–35.
Cost Estimates of COVID-19 Clinical Management in Myanmar

Abbreviations

World Health Organization: WHO; Ministry of Health and Sports: MoHS; Coronavirus Disease 2019: COVID-19; Average length of stay: ALOS; Intensive care unit: ICU; USD: The United States dollar

Acknowledgements

The authors would like to acknowledge and thank Medical Superintendents and data providers of Waibargi Specialist Hospitals, Phaunggyi COVID-19 Treatment Center, COVID Center(Thuwanna), and the responsible officials from the procurement section, medical care section, central epidemiology unit of Ministry of Health and Sports. Our very special thanks should be extended to the representatives from Medical and Health related Universities and Department of Medical Services who have reviewed the manuscript and provided the technical comments.

Author’s Contribution

PWT conceptualized the research and prepare the manuscript. PWT, KTH and WYW collected and analyzed the data. TSH and YMH reviewed, edited the drafts and provided general oversight. All authors read and approved final manuscript.

Sources of Funding

None

Availability of data and materials

The datasets analyzed during the current study are available from the corresponding author on reasonable request.

Ethics approval and consent to participate

The ethical approval was given by the ethical review committee of University of Public Health, Ministry of Health and Sports, Myanmar. All methods were carried out in accordance with relevant guidelines and regulations. Before data collection, informed consents were obtained by explaining the objectives of the study and the necessary data from all participants including the responsible officials from the health facilities and the concerned departments. Most of the data were collected by reviewing and recording the administrative and financial records of each facility and department.

Consent for publication

Not applicable

Competing interests

The authors declare that they have no competing interests.
Cost Estimates of COVID-19 Clinical Management in Myanmar

Author details
Authors are from National Health Plan Implementation Monitoring Unit, Minister’s Office, Ministry of Health and Sports, Myanmar.