



International Journal of Health Systems Resilience

INJHSR
International Journal of
Health Systems Resilience

Original Research

ISSN 2950-7405



Assessment of Island Wide Distribution and Requirement of Biomedical Equipment for COVID-19 Case Management in Government Hospitals of Sri Lanka

G.H.S. Fernando¹, B A H M Gunasena², A S Yapa Bandara³, Lal Panapitiya⁴

1 Senior Registrar in Medical Administration, DDG (MS), Ministry of Health, 2 Senior Registrar in Medical Administration, DDG (MS), Ministry of Health, 3 Registrar in Medical Administration, DDG (MS)1, Ministry of Health, 4 Director medical services, 5 DDG medical services

*Correspondence: ghsfernando@gmail.com



<https://orcid.org/0000-0001-7356-6257>

Submitted: 05/01/2022

<https://doi.org/10.51595/INJHSR22/002>

Published: 01/10/2022

Abstract

According to the World Health Organization, the critically ill patients of SARS-CoV-2 require mechanical ventilation as the virus (henceforth referred to as COVID-19), through a variety of mechanisms, disrupt the capacity for oxygenation of the infected. The availability of oxygen for patients through mechanical means is thus an essential means of treatment, required for the effective management of COVID 19. Ergo, it is understood that all the COVID 19 treatment centers should be equipped with pulse oxygen meters and a functioning oxygen supply system including single use oxygen delivery interfaces. In the Sri Lankan context however, the correct number of available equipment list was not available in the databases of Ministry of Health, Sri Lanka. It is understood that the availability of a database of essential equipment is essential as it allows policy makers to make effective decisions, prescribe actions by assessing the readiness of medical institutions in facing the pandemic. As such, the aforementioned Ministry and the Deputy Director General Medical (DDG) MS 1) collected information on essential medical equipment in each relevant institute through a web-based system. The objective of this assessment was to collect information of medical equipment related to the efficient and effective management of COVID 19 patients of Government Hospitals. This assessment collected data only from the state of Sri Lanka, and as such, the subsequent terms Ministry of Health and Government Hospitals refer to the Ministry of Health Sri Lanka, and Government Hospitals in Sri Lanka, unless stated otherwise.

Key words: COVID 19, Medical equipment, WHO, Oxygen, Sri Lanka

1. Introduction

Coronavirus disease (COVID-19) is an infectious disease caused by a newly discovered coronavirus (1). It was named as acute disease as Severe Respiratory Syndrome Coronavirus 2 (SARS-CoV2) by the international Committee on Taxonomy of Viruses (2). The COVID 19 is originated in Wuhan city of China in December 2019 and spread to all over the world within a short period of time (3). According to the data from China, the majority of people with COVID 19 have mild illness (40%) or moderate illness (40%), while 15% of them have severe illness requiring oxygen therapy and 5% will be critically ill (4).

According to the World Health Organization (henceforth referred to as WHO), the critically ill COVID 19 patients require mechanical ventilation (5, 6). Therefore, oxygen is an essential medicine for COVID 19 management (7). The WHO technical guideline mentions to maintain oxygen saturation more than 94% (SpO₂) patient presented with respiratory distress (8). Ergo, all the COVID 19 treatment centers should be equipped with pulse oximeters and functioning oxygen delivery systems including single use oxygen delivery interfaces (8). Most severe cases require fully equipped ICU facilities with mechanical ventilator devices and accessories, monitoring facilities, infusion pumps for nutrition and drugs/fluid supplement (9). The WHO has issued a priority list of biomedical equipment and their specifications for COVID 19 management in order to face this pandemic (10,11,12,13). The provision of healthcare supplies is a product of the robust international supply chain that provides timely delivery to healthcare systems around the world (14).

However, the COVID-19 pandemic has disrupted the healthcare supply chain worldwide (14). It is thus essential to assess the availability of essential equipment, since availability of essential medical equipment to support patients affected by COVID 19 is globally limited (9).

The availability of Oxygen is a key determinant of the survival of patients who go into severe stages of COVID-19, as per WHO (4). In Sri Lanka, there are 130 secondary and 30 tertiary care hospitals that

are equipped to treat COVID positive patients using essential medical equipment. However, the actual number of available equipment list is not available in the Ministry of Health. It is understood that the availability of a data base of essential equipment is essential as it allows policy makers to make effective decisions to counter this deadly pandemic. A said database is further necessary in assessing the readiness of medical institutions in facing the pandemic and ensuring the quota of said instruments and medicines are always met.

Thus, as a responsible unit, the Deputy Director General Medical (DDG) MS 1) collected information on essential medical equipment in each relevant institute through a web-based system.

2. Objective

The objective of this assessment was to collect information of medical equipment related to the efficient and effective management of COVID 19 patients of Government Hospitals.

3. Methodology

A web-based software (HIUS) was introduced connecting all hospitals in Sri Lanka, and a password and a username system was introduced to relevant hospitals. The system was updated regularly by a designated focal point in each hospital. The information related to oxygen therapy for COVID 19 patients were collected.

This assessment was implemented in three steps.

1. Categorization of essential equipment for oxygen supply
2. Development of a web-based system to collect information
3. Summarization of available equipment throughout the country to face critical situations

3.1 Categorization of essential equipment for oxygen supply

The list of equipment was listed out by focal group discussion with the DDG MS 1, Senior Registrar in Medical Administration. WHO guidelines on essential equipment were considered during this discussion. The comments were taken from the expertise in the medical field before finalizing the equipment list.

3.2 Development of a web-based system to collect information

A software was developed with the help of the expert in Information Technology field in order to collect the pertaining information. The system was named as Health Information Updating System (HIUS). A username and a password were given to all relevant hospitals and an updating system was established with the help of trainees in MD medical administration. All aforementioned Hospitals were advised to name one focal point in order to update the system regularly. They were advised to update the information relevant to stocks of medical equipment weekly, therein the Ministry was able to see the updated equipment list. A single senior registrar is managing the system centrally to facilitate the other stakeholders.

3.3 Summarization of available equipment throughout the county to face in critical situations

The system is generating a list of medical equipment according to the institution automatically. The following available island wide equipment list was listed using the information above.

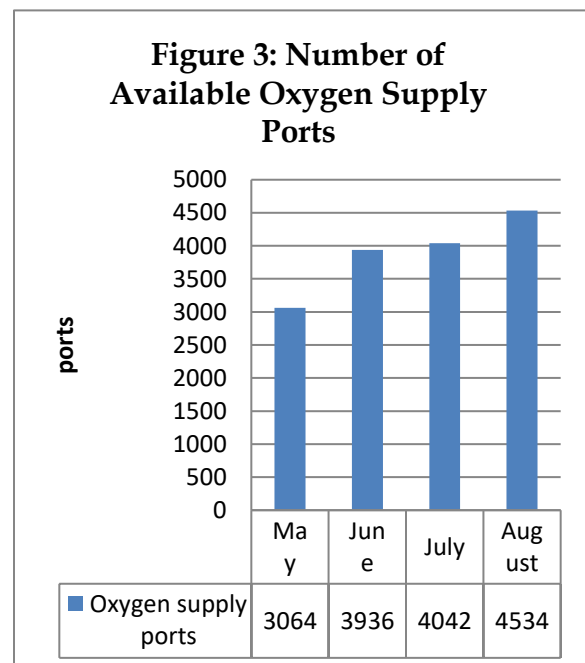
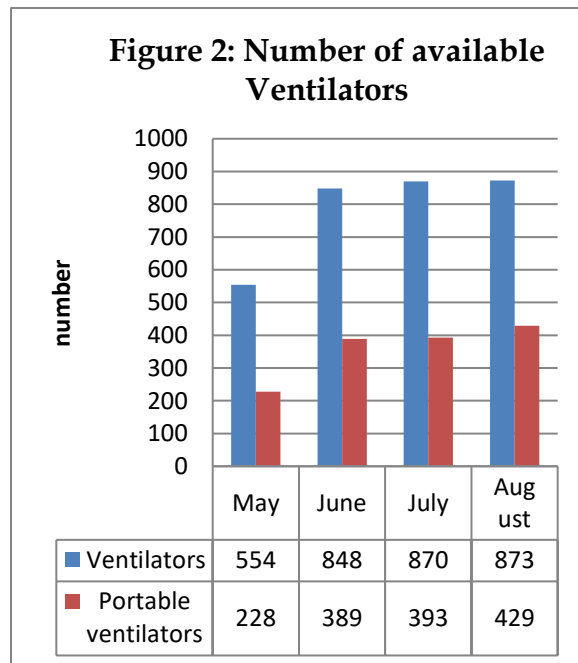
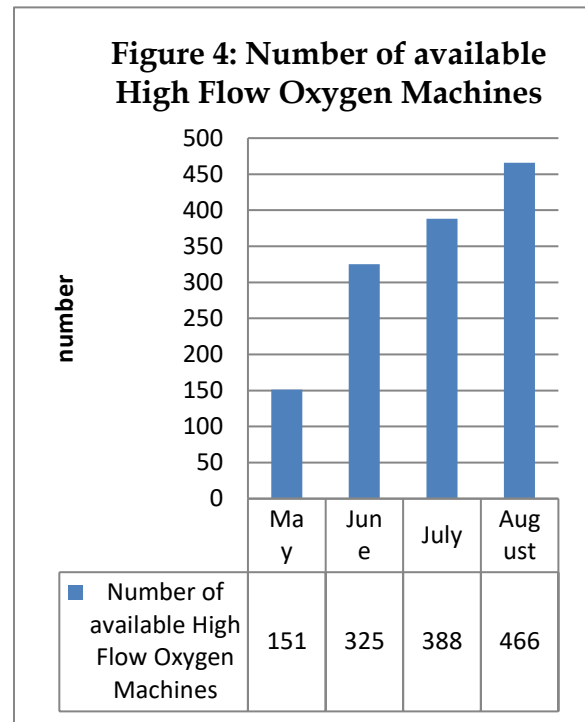
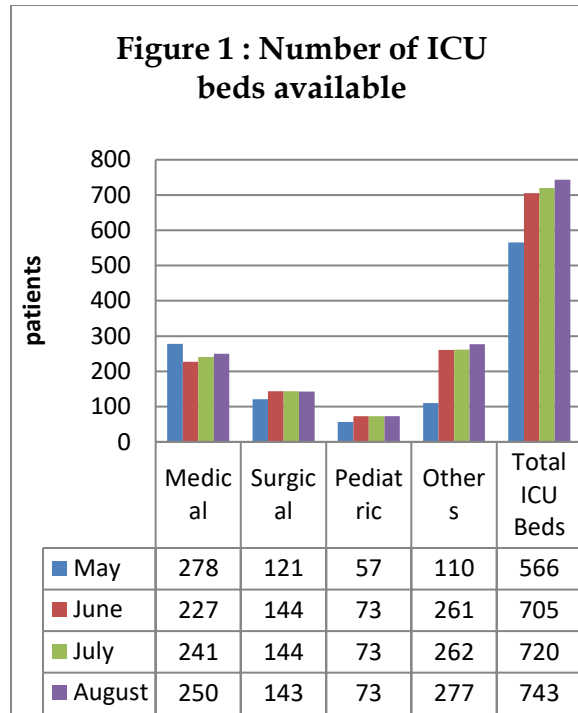
4. Results

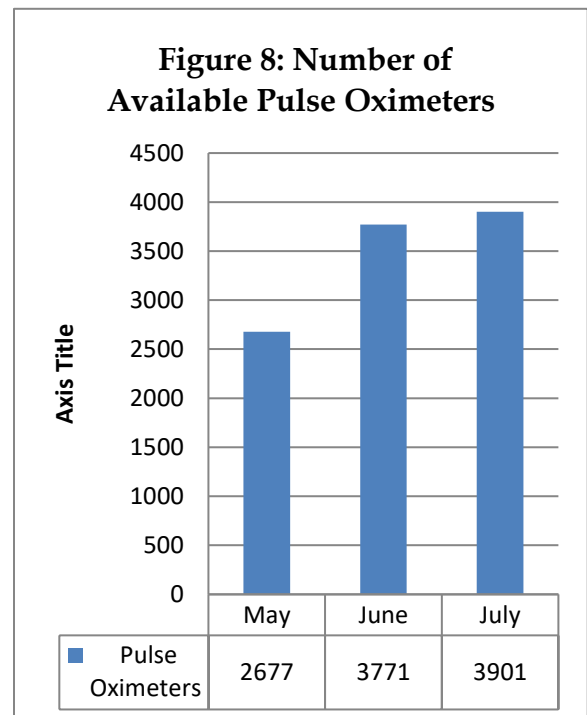
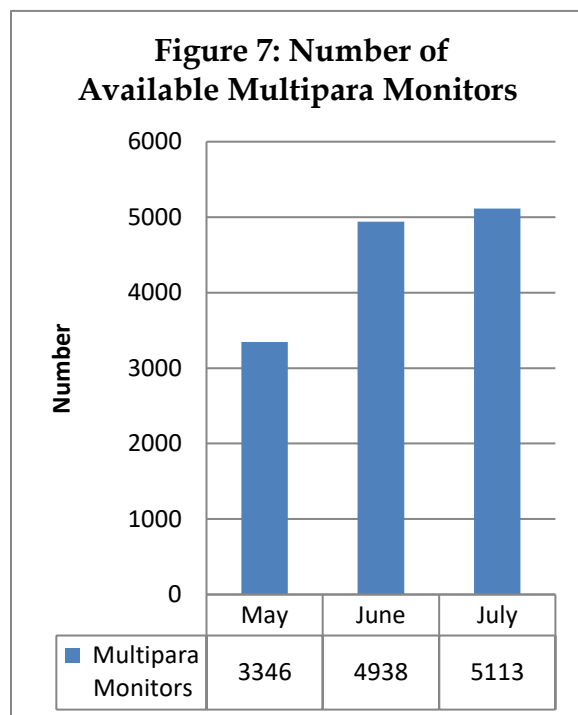
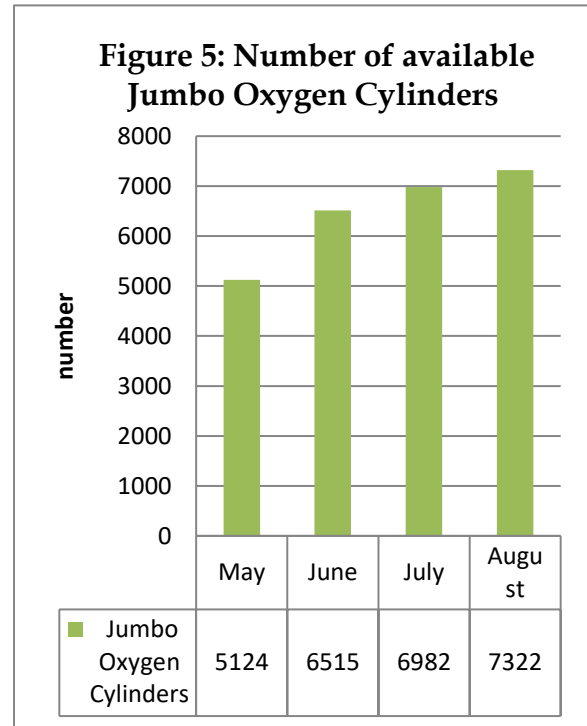
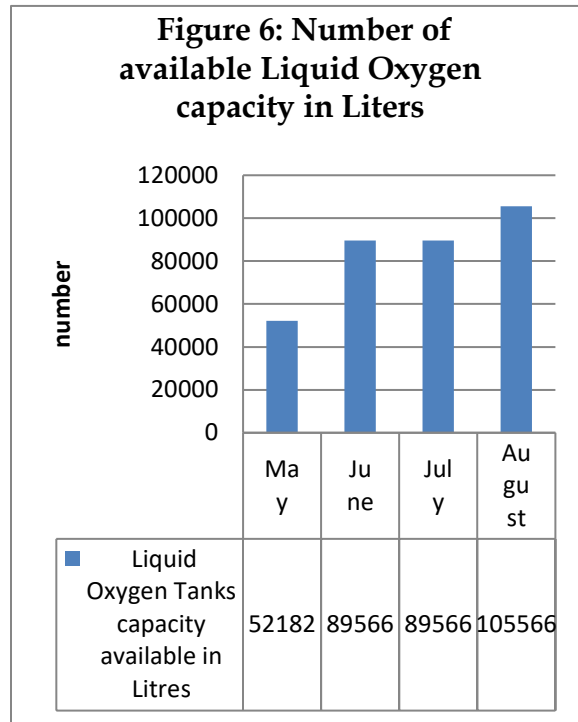
At the beginning of June 2021 there were 566 ICU beds, 544 Oxygen ventilators, 228 Portable Ventilators, 3064 Oxygen ports, 151 High Flows systems, 5125 Jumbo cylinders, 52182 Liters of liquid oxygen, 3346 Multipara Monitors and 2673 Pulse Oxi-meters available in all hospitals to manage oxygen dependent patients. At the end of August, the aforementioned values increased to 743 ICU beds, 873 Oxygen Ventilators, 429 Portable Ventilators, 4534 Oxygen ports, 466 High Flows systems, 7322 Jumbo cylinders, 105566 Liters of liquid oxygen, 5113 Multipara Monitors and 3901 pulse Oxi-meters, 392 CPAP and 301 BIPAP machines, which were available to manage oxygen dependent patients.

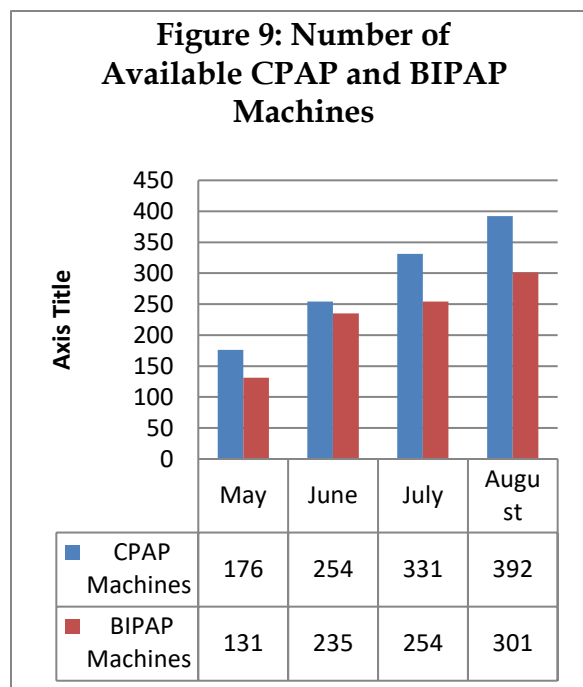
The results will be illustrated in the tables and figures below.

Table 1: the List of medical instruments audited

Instruments	By June 2021	By August 2021
ICU beds	566	743
ICU ventilators	554	873
Oxygen ports	3064	4534
Portable ventilators	228	429
C- Pap	176	392
Bi- pap	131	301
High flow machine	151	466
Jumbo cylinders	5124	7322
Liquid Oxygen tanks	52182 L	105566 L
Multipara monitors	3346	5113
Pulse Ox meters	2673	3901
Infusion pump	4974	5148
Syringe pump	5541	5697

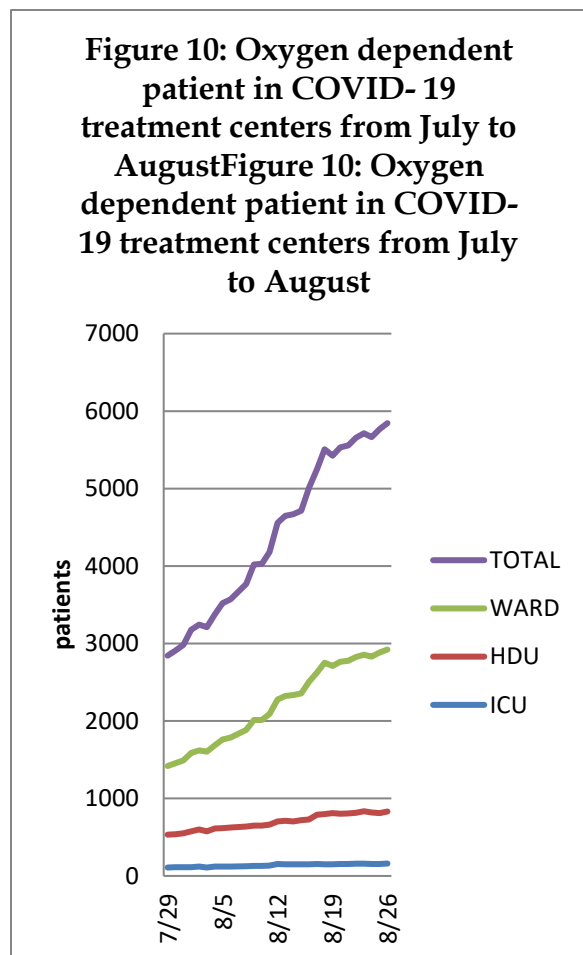






5. Discussion

COVID 19 had complex negative effects on the availability of biomedical equipment and medical supplies. WHO has introduced several formats to evaluate the availability of essential equipment in order to assess the current distribution of said equipment in order best respond to the COVID 19 Pandemic. During the 1st and 2nd waves in Sri Lanka, the majority of the patients were asymptomatic and only few patients required oxygen therapy. During the said waves, the new Delta variant was under contagion all over India. The Delta Variant has a higher transmission rate and as well as higher oxygen dependency rate (15). The variant caused an alarm, thereby resounding the call to assess the current oxygen supply in Sri Lanka in order to maintain a healthy oxygen supply. At the onset of COVID 19 outbreak, the Ministry of Health did not have accurate figures on distribution of oxygen supply equipment in the country. As such, patients were managed with available resources in the country.



Thus, the Deputy Director General medical service 1 conducted an audit to collect information on the current level of supply of medical equipment necessary for oxygen therapy. The exercise was planned to as a continuous system in order to observe the progress of the infrastructure development in hospitals. The exercise was carried out through the use of a donated software developed with the help of a private organization, which collected the information required for the audit. The software was named the health information upgrading system (HIUS) and commenced operation on 27/06/2021. The data collected included basic information such as hospital bed capacity, number of beds allocated for COVID 19 patients, number of COVID 19 infected and admitted patients and specific data in relation to oxygen therapy, such as number of patients in the ICU, HDU, number of available instruments supported to deliver oxygen. All hospitals were instructed to update general information daily and specific information weekly or once new instrument is available.

A comprehensive audit on medical equipment and hospital information were initially completed in July 2021. According to the audit, by May only 566

ICU beds were available in the country to managed critically ill patients. Most of the oxygen dependent COVID 19 patients were managed in high dependency unit (HDU). Furthermore, only 494 HDU beds were allocated island wide to manage COVID patients. As such, the threat was recognized by the Ministry of Health and all heads of the healthcare institutions were notified to increase number of ICU beds and HDU beds. Following such a notification, the total ICU beds by end of the August were increased up to 743. While only 160 ICU beds were allocated for COVID 19 patients in June, the number of allocated beds increased to 211 by the end of August. In parallel to the increase in ICU beds, the HDU beds allocated for COVID 19 patients also increased from 494 beds to 980 beds during the same period. At the 2nd and beginning of the 3rd wave less than 500 patients were managed in the ICUs and HDUs. However, at the end of the August more than 1000 patients were managed in ICUs and HDUs. This improvement was made as a result of this audit, thereby cured more patients (16). According to the HIUS system only few ICU and HDU (around 1000) were allocated to manage oxygen dependent patients, but it shows nearly 3000 (figure 10) patients are oxygen dependent in the government hospitals. All other patients were managing through an inward set up using non -invasive ventilators such as Bi-pap, C-pap and high flow oxygen machine. Other oxygen dependent patients were managed using oxygen concentrators. Oxygen supply for the Noninvasive ventilator were delivered through the oxygen outlets developed within the inward set up under the instruction of Ministry of Health. In June 2021, Sri Lanka had only 3064 oxygen outlets, which was increased up to 4534 by August 2021(Figure 4). Despite having approximately 1500 ICU beds and HDU beds by August, more than 3500 patients were managed with oxygen therapy per day using these newly developed oxygen outlets and non-invasive ventilators. In order to support patient management with oxygen, Ministry of Health increased high flow machine from 151 to 456, Bi-pap from 131 to 301 and C-pap from 176 to 392 during this period. Furthermore, the capacity of Jumbo cylinders has been improved from 5124L to 7322L, and capacity of liquid tank was increased from 52182L to 105566L. Multi Para monitors and pulse oxi-meters, infusion pumps and syringe

pumps are noted to be essential supportive medical instrument in managing COVID 19 patients. However, there were limited amount of those equipment allocated to manage the patients. As such, by the end of August, 5113 multipara monitors and 2901 pulse oxi-meters were added to the island wide Health system (figure 8 and 9).

At present now more than 3000 oxygen dependent patients are managed on a daily basis at Government Hospitals without a backlog. With the attack of Delta variant, the number of oxygen dependent patients were suddenly increased during the 3rd wave. Since the Ministry of Health had taken correct decisions to increase the number of oxygen delivery instruments, most of the oxygen dependent patients recovered from COVID-19. Such an increase was a direct causation of the implementation of the HIUS and the audit, which thus was very helpful to take decisions to improve the system. However, the system is upgrading in order to include more information such as number of antigen and PCR tests done, value of positive rates per unit time, and the information of patients in the intermediate care centers. Such information will be provided on a COVID related information hub in the future to facilitate pertaining decisions.

6. Conclusion

HIUS is successfully implemented in order to collect information related to oxygen supply. The Audit information was used for the development of the COVID-19 treatment center with essential equipment and oxygen. More than 3500 oxygen dependent patient were managed in the peak time without an interruption of oxygen supply.

7. Recommendations

It is recommended to continue the audit of biomedical equipment with the progress of COVID-19 pandemic with the possibility of future waves of infection

References

1. WHO (2021). Coronavirus. Retrieved on 01/07/2021. Available at: https://www.who.int/health-topics/coronavirus#tab=tab_1
2. Kumar A, Luthara S, Mangla SK, Kazancoglu Y (2020). COVID 19 Impact on sustainable production and operations management. Sustainable production and operations management. KeAi Chinese roots Global Impact. V(1).1-7. Retrived on 01/07/2021.Available at: <https://www.sciencedirect.com/journal/sustainable-operations-and-computers/vol/1/suppl/C>.
3. H.A. Rothan, S.N. Byraredy (2020). The epidemiology and pathogenesis of coronavirus disease (COVID-19) outbreak. Available at: <https://www.sciencedirect.com/science/article/pii/S2666412720300015>.
4. WHO (2020) Oxygen sources and distribution for COVID-19 treatment centers. Interim guidance. Retrieved on 03/07/2021. Available at: <https://www.who.int/publications/i/item/oxygen-sources-and-distribution-for-covid-19-treatment-centres>
5. Yang X, Yu Y, Xu J, et al. Clinical course and outcomes of critically ill patients with SARS-CoV-2 pneumonia in Wuhan, China: a single-centered, retrospective, observational study. *Lancet Respir.* 2020. doi:10.1016/S2213-2600(20)30079-5.
6. Wu Z, McGoogan JM (2020). Characteristics of and important lessons from the coronavirus disease 2019 (COVID-19) outbreak in China: summary of a report of 72 314 cases from the Chinese Center for Disease Control and Prevention. *JAMA.*; 323 (13):1239-1242. doi:10.1001/jama.2020.2648.
7. WHO (2020). Biomedical Equipment for COVID-19 Case Management Interim guidance. Inventory tool for facility readiness and equipment re-allocation. Retrieved on 02/07/2021.Available at: https://www.humanitarianresponse.info/sites/www.humanitarianresponse.info/files/documents/files/who-2020_covid19_bioequip.pdf.
8. WHO (2020). Clinical management of severe acute respiratory infection (SARI) when COVID-19 disease is suspected: Geneva: interim guidance. Retrieved on 07/07/2021. Available at: <https://apps.who.int/iris/handle/10665/331446>.
9. Garzotto F, Ceresola E, Panagiotakopoulou S, Menotto F, Benozzi M et.al. (2020). COVID-19: ensuring our medical equipment can meet the challenge. *Expert Review of Medical Devices.* P (483-89). Retrieved on 07/07/2021. Available at: <https://www.tandfonline.com/doi/full/10.1080/17434440.2020.1772757>.
10. World Health Organization (2020) Disease commodity package - Novel Coronavirus (COVID-19).
11. World Health Organization (2019) UNICEF, Technical specifications and guidance for oxygen therapy devices: p. 164.
12. World Health Organization (2016). WHO Technical Specifications of Neonatal Resuscitation Devices.
13. World Health Organization (2015). Technical specifications for oxygen concentrators.
14. Khot UN (2020). Navigating Healthcare Supply Shortages During the COVID-19 Pandemic. Retrived on 31/07/2021. Available at: <https://www.ahajournals.org/doi/10.1161/CIRCOUTCOMES.120.006801>.
15. Xinhua (2021). Sri Lanka faces 4 mutations of Delta variant as COVID-19 spreads. *Asia & Pacific.* Retrieved on 06/09/2021. Available at: http://www.xinhuanet.com/english/asiapacific/2021-08/23/c_1310143823.htm.
16. Ministry of Health (2021). HIUS update. COVID 19 review meeting held at ministry auditorium on 05/09/2021.