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Design of a COVID-19 treatment facility in a sustainable health-care environment

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ABSTRACT

Due to the recent pandemic situation that has erupted all around us, healthcare facility design is a must. Healthcare providers and administrators must concentrate on the changes that must be made in existing healthcare facilities. The isolated healthcare facilities are essential because the corona virus is spread mainly through close contact (within six feet), such as handshaking (if someone's hands are infected) or touching contaminated surfaces. Healthcare facilities are most susceptible to the spread of the corona virus due to the high number of symptomatic patients admitted. Coronavirus is the leading cause of infectious disease morbidity and mortality worldwide. Thus, if the pandemic situation worsens, new plans and designs for existing healthcare facilities will be required, as well as temporary versions. Societal gains from increased research in this area. In the coming years, healthcare workers will be better trained, and healthcare facilities will be upgraded. This paper proposes new plans and designs to address the issues raised.

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1. Introduction

The primary concern is the healthcare facility, owing to the ongoing pandemic situation. Numerous countries are confronted with this issue, and the majority of them are unable to address the issue of healthcare infrastructure. [1]. Environmental conditions, such as air pollutants, household crowding, humidity, hygiene, season, and temperature; availability and effectiveness of medical care and infection prevention and control (IPC) measures to contain spread, such as vaccines, access to health-care facilities, and isolation capacity; and the host factor are all factors that influence the severity of severe acute respiratory infections. Because several countries are still conducting research into the vaccine, a lockdown can only be implemented for a limited period of time. In the absence of vaccines, lockdown cannot be the only option, and social distancing can be employed until such time as they are developed. To ensure effective social distancing and to

reduce the impact of this virus, the proposed plans and design in the healthcare facilities may be beneficial to both healthcare providers and the general public.

It is critical to understand the dynamics of emerging infectious disease threats because they usually begin at a local level and have the potential to spread across populations and overwhelm health-care systems. Most epidemic and pandemic diseases progress through four distinct phases, though not all epidemic diseases progress through each phase in the same manner. Fig. 1 depicts the different stages of an epidemic.

COVID-19 Care hospitals/centres design and plans for various areas such as building design (including ventilation), restricted movement of people bound to follow design measures, construction and management, and hygiene are dealt with in this work primarily. It is intended for use primarily in health-care settings in precarious situations, as well as in situations where simple and

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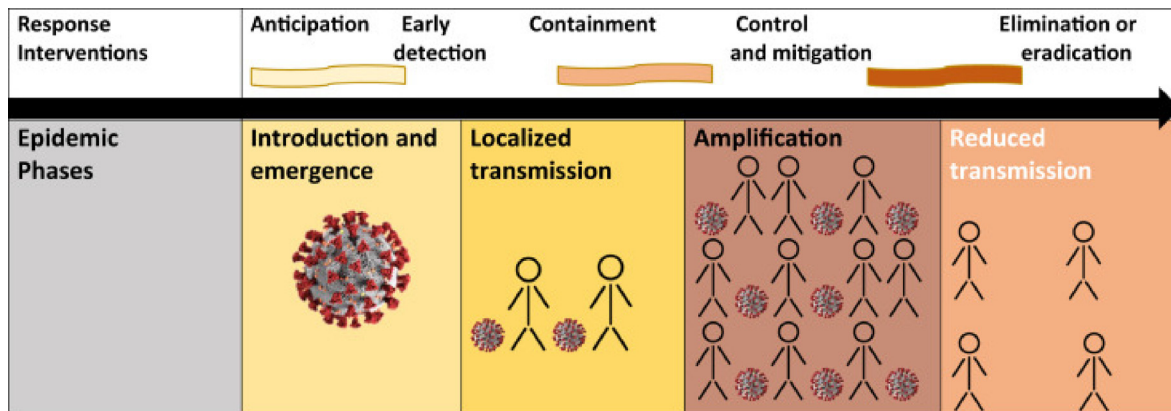


Fig. 1. Phases of an Epidemic [2].

affordable measures can make a significant difference in terms of hygiene and health.

2. Methodology and design

Corona viruses (CoV) are a large family of viruses that cause human illness ranging from a common cold to more severe diseases like SARS (SARS-CoV). On December 31, 2019, a new strain of the novel corona virus (nCoV) was discovered in humans in Wuhan, China [2]. Capacity managers are responsible for taking action toward implementing an accurate anticipatory and control strategy in the workplace. To mitigate the impact of COVID-19, changes to the current infrastructure or makeshift arrangements are required to maximise the use of available resources. These changes are necessary because a disciplined population will help contain the pandemic. Lockdown is a temporary solution, not a permanent one. People are necessary for industries, offices, healthcare, educational institutions, etc. to function. Because COVID-19 patients are being treated in healthcare facilities, several changes or modifications are required in every aspect of healthcare facility

management. In this paper, we propose some strategies to combat or contain the corona virus.

2.1. Various transmission scenarios in a healthcare setting

The majority of the time, patients with mild symptoms visit the primary healthcare facility centres for a checkup. The healthcare staff investigates the symptoms and recommends that the patient either stay at home and quarantine for 2–3 days or go to a hospital for further treatment. Whenever the symptoms are severe and require further investigation, patients are referred to nearby hospitals for testing and additional medical tests such as chest X-rays and other procedures as recommended by the healthcare professionals. During this journey from primary healthcare facility to hospital, the patient may come into contact with a number of people who may not be infected, and the patient may unintentionally spread the virus to others[1]. The journey from the primary healthcare facility to the hospital is depicted in Fig. 2.

We propose some changes for suspected patients, as well as dedicated corridors for their movement within the hospital, for this

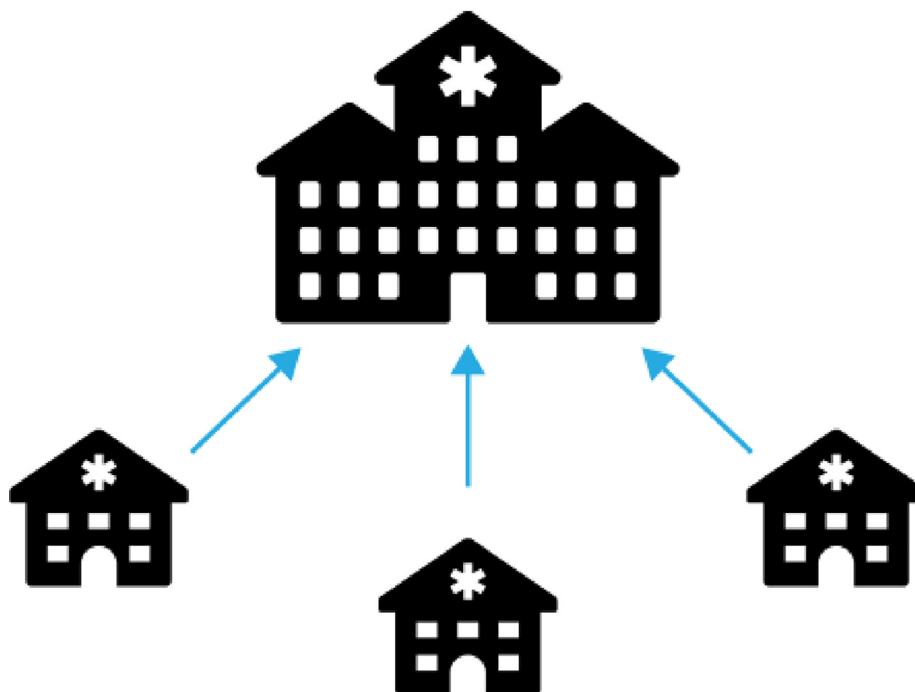


Fig. 2. Patient Transfer from Primary Care to Hospitals.

journey. Among the steps that can be taken are reducing personnel concentration, reducing physical proximity of staff, cleaning and disinfecting, and keeping every-one informed. All of the steps necessitate changes to the signage boards so that suspected patients, healthcare staff, and the general public understand the gravity of the pandemic. Restricted pathway signs, dedicated washrooms, restricted movement signboards, dedicated floors for suspected patients, and mandatory hygiene notices can all be found in various areas of hospitals. If any suspected patients are found to be Corona positive, they must be transferred to COVID Treatment Hospitals. Fig. 3 depicts the critical phase of the journey that requires controlled/restricted patient movement.

Throughout this journey, a dedicated team of healthcare professionals and security are required, as this virus is harmful to patients' physical and mental health, as evidenced by several incidents over the last few months. Dedicated corridors should be developed at primary health facilities and hospitals, and positive patients should exit through any other gate. This will help reduce the likelihood of corona. After arriving at the COVID Treatment facility, several areas must be addressed. Respiratory viruses are generally spread via droplets created by coughing or sneezing or via infected surfaces [3]. The steps to spread this deadly virus. Various studies show that ventilation is important in healthcare facility design. There are three types of building ventilation: natural, mechanical, and hybrid [4]. It is suitable for critical patient rooms/wards. We recommend Top down hybrid ventilation with HEPA filters or UV light ducts. Figs. 4(a) and 4(b) depicts Top Down Hybrid Ventilation with HEPA Filter and UV Ducts. In addition, a NO ENTRY signboard should be pasted on the wall.

Patient screening necessitates careful resource management and medical staff safety. As shown in Fig. 5, two zones can be created for screening: staff and patients. Separate hand washing stations for patients and staff. The WHO recommends a 2 m distance between patient and staff. Large tent-like waiting rooms, isolation chambers, etc. can be made with natural ventilation [5]. Fig. 5 shows the temporary tent based screening plan.

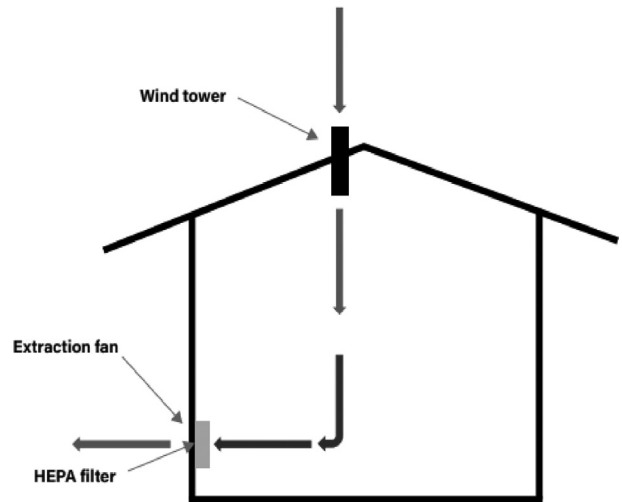


Fig. 4a. Top Down HEPA & UV Duct Ventilation.

The ICMR and WHO recommend following protocols while identifying, selecting, and surveying potential COVID-19 treatment sites [7]. The design can be adjusted to different climatic conditions and can use permanent buildings and existing hospital isolation or unused wards.

The available area in any COVID-19 Treatment facility or centre should be divided into three or four zones [6]. First, the healthcare staff or working area, then the patient with mild symptoms, then severe cases with corona, and finally critical cases requiring enhanced ventilation and extreme care. The healthcare experts involved in the treatment classify the patients into zones. Delineating and separating patient and staff areas also helps reduce risk for health-care workers and allows for rational use of protective kits. Fig. 6 depicts a tent type COVID-19 Treatment facility.

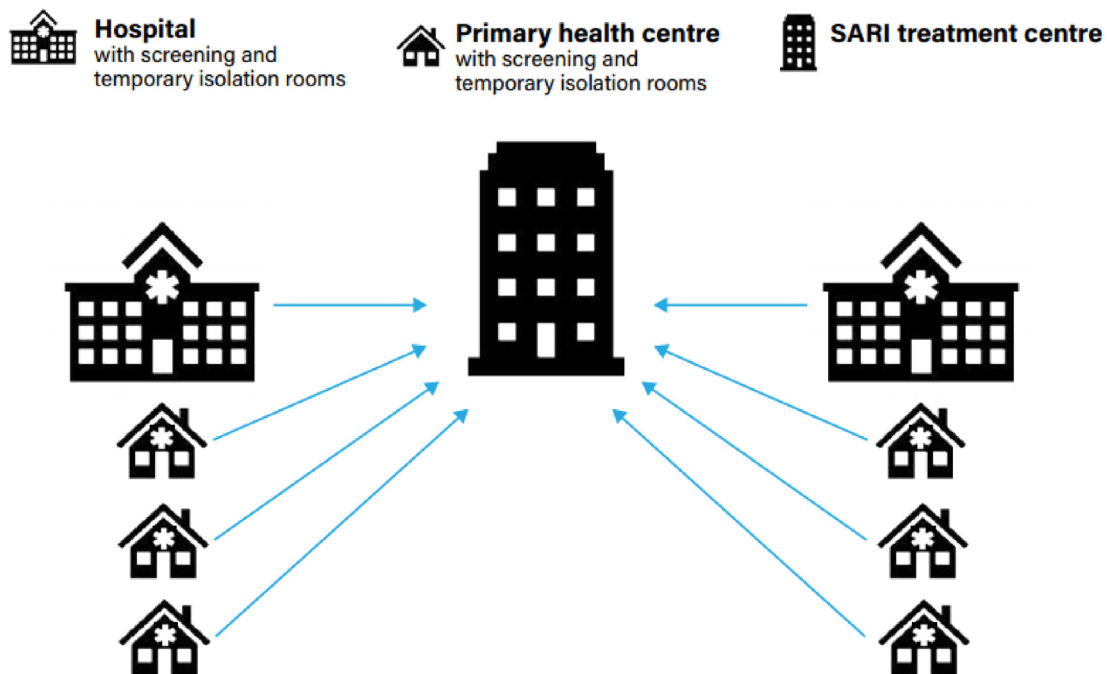


Fig. 3. Patient journey from primary care to COVID treatment.

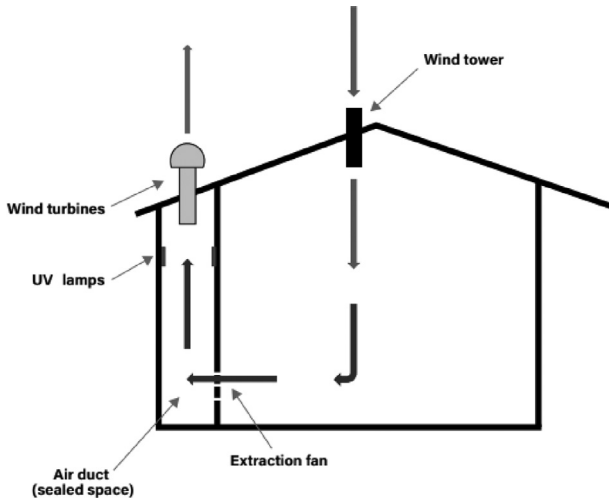


Fig. 4b. UV Duct Ventilation.

The COVID-19 treatment centre includes areas for waste and medical waste disposal, water treatment, cleaning services, dead body storage and secure transfer, biomedical device sanitization, and PPE kit disposal. Plans can also be made to reduce the spread of Corona virus. However, logistic sanitation is also an important aspect in hospitals. It also required planning where the sanitization machine would be placed in the hospital.

3. Conclusion and future scope

The proposed plan discussed above shows that healthcare facilities need to be modified to combat the corona virus. The proposed plans can effectively manage available resources in terms of patient transfer, screening, and isolation if executed with care. The COVID-19 treatment centre modifications and temporary arrangements depict that it is necessary to separate the various corona patient types ranging from moderate, severe, critical in zones. As a result, the critical patient will be able to receive proper treatment, increasing their chances of survival. Standardization

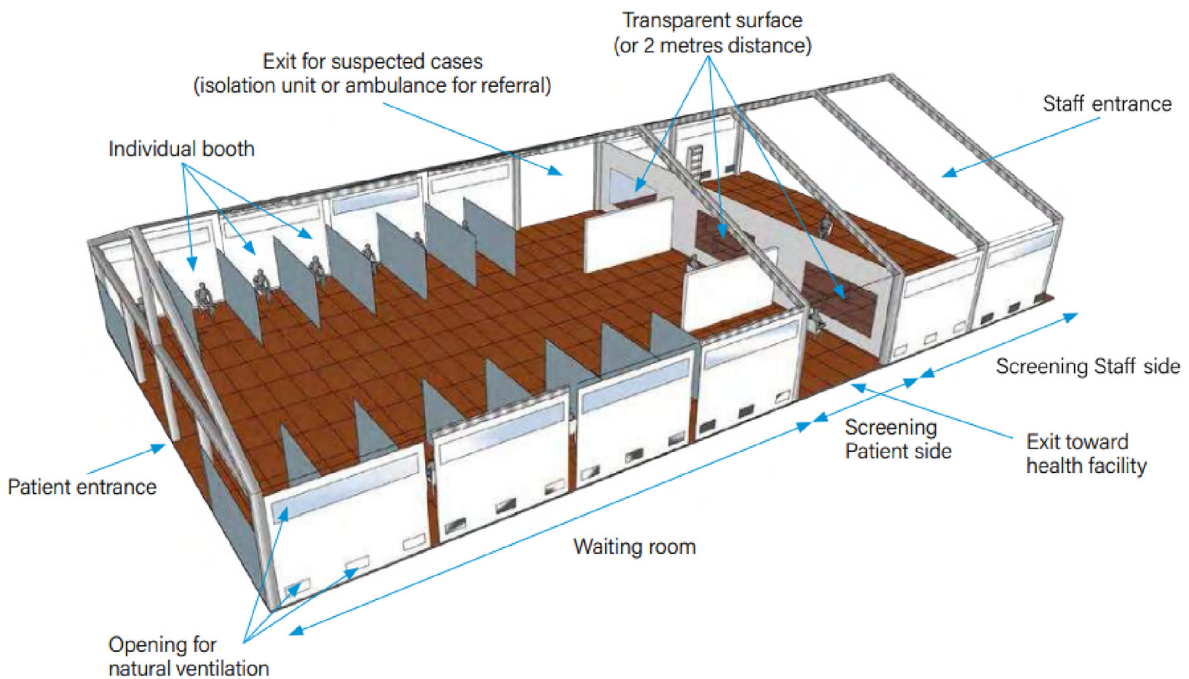


Fig. 5. Tent-based screening plan.

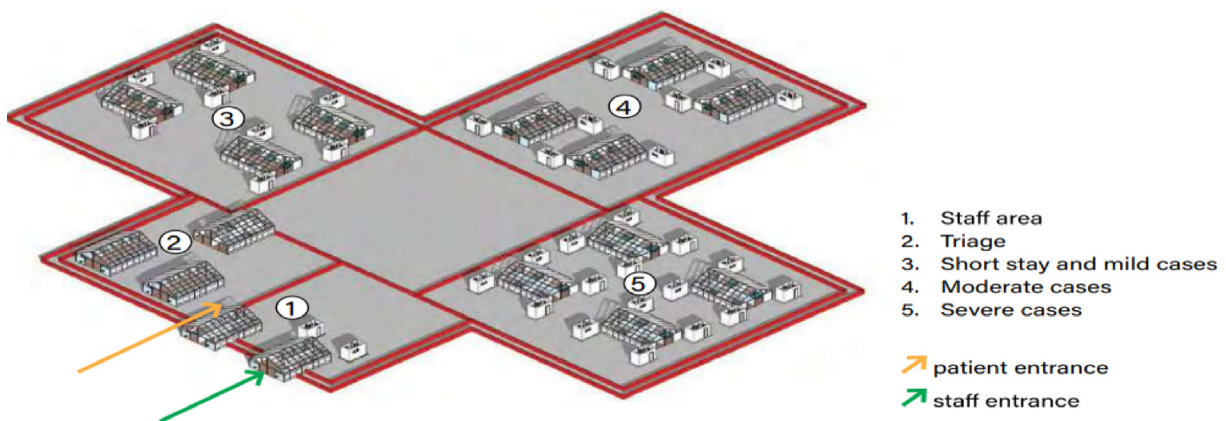


Fig. 6. Tent Type Temporary arrangements for COVID-19 Treatment Centre.

can be applied to various facilities such as sanitization of biomedical devices and PPE kits, as well as waste disposal and water treatment. The lessons learned from this pandemic will benefit future generations, and all governments, as well as the general public, must recognise the importance of various healthcare factors. Workplaces, homes, schools, parks, sporting events, and other venues can all benefit from similar designs. Dedicated pathways with appropriate signage may also help people focus on issues other than social distance.

CRediT authorship contribution statement

Bharat Bhushan Sharma: Conceptualization, Methodology, Writing – original draft. **Manoj Mathur:** Data curation, Formal analysis. **Vijay Mohan:** Writing – review & editing.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

References

- [1] COVID-19: Operational guidance for maintaining essential health services during an outbreak March 2020. Geneva: World Health Organization; 2020
- [2] [R. Chigurupati et al., J. Oral Maxillofac. Surg. 78 \(8\) \(2020\) 1241–1256.](#)
- [3] Testing and troubleshooting of ventilation systems. Carolinas Section AIHA;
- [4] [N.G. Reed, Public Health Rep. 125 \(1\) \(2010\) 15–27.](#)
- [5] Best practices for environmental cleaning in healthcare facilities in resource-limited settings. Atlanta: Centers for Disease Control and Prevention; 2019.
- [6] [W. Wang et al., JAMA 323 \(18\) \(2020\) 1843–1844.](#)
- [7] Ministry of Health and Family Welfare, Government of India.COVID-19 India.