

Alternative care sites for surge capacity during pandemics

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ABSTRACT

Alternative care sites (ACS) across Egypt were widely underutilized during the coronavirus (COVID-19) outbreak, while the number of patients and severity of their cases overwhelmed the healthcare system. The challenges brought on by the pandemic have shown the necessity of designing surge capacity to control the situation. This research aims at reviewing some successful response actions of the Republic of China and the United States of America in creating alternative care sites. That was through archival data analysis and comparison between different approaches across the two countries. The study can help by reflecting on Egyptian policies and strategies to relief stress on the healthcare system.

KEYWORDS: Alternative care sites, Adaptive reuse, Pandemics, Covid-19.

1. Introduction

The world is facing one of the biggest disasters in modern history, the corona virus disease; an infectious disease, caused by severe acute respiratory syndrome corona virus 2 (SARS-CoV-2). The disease's first case was identified in December 2019, in Wuhan the capital of Hubei province in China. It has spread vastly and globally since then, resulting in the ongoing 2019-2022 pandemic (world health organization, 2019). The main key features that define a pandemic are the wide geographic extension, novelty, disease movement, severity, high attack rates, explosiveness, minimal population immunity, infectiousness, and contagiousness (Mardon, Tang, Colwell, & Sivachandran, 2020; Centers for Disease Control and Prevention, 2016).

Very few phenomena in human history have had the same impact on our societies and cultures as outbreaks of infectious diseases; yet remarkably little attention has been paid to these phenomena (Huremović, 2019). Public health crises are threat for humans since ancient times, Since the 1500s, influenza pandemics have struck around three times every century, or roughly every 10-50 years, and killed millions of people, and destroyed powerful empires. (Mardon, Tang, Colwell, & Sivachandran, 2020; Centers for Disease Control and Prevention, 2016).

Pandemics are unpredictable and inevitable. It is expected that there will not be a protective vaccine for six months or longer after the virus is identified, and even then, there will be a universal deficit of doses (Ghebreyesus, 2018). This makes its prevention and response critically important, on both the national and global levels (Mardon, Tang, Colwell, & Sivachandran, 2020; Centers for Disease Control and Prevention, 2016).

During a pandemic, it's expected that, at some point, hospital capacity will not be able to cover such a large number of patients due to the spread of the disease and hospitals' unpreparedness to host such a large number of patients, so alternative care sites will be required, to serve as a surge capacity for medical screening, triage and patient care. As a result, it's critical to be able to scale up the delivery of health interventions proportionately to the severity of the event, the pathogen, and the population at risk (Madhav, et al.), (AIA, 2020). This makes us obligated as architects to support our healthcare practitioners who are on the front lines of the pandemic, especially today, given the tremendous demand.

This research is concerned with exploring some successful response actions to satisfy surge capacity during the covid-19 pandemic, focusing on the Republic of China, the United States of America, in order to help in reflecting on Egypt's strategies and policies. The researcher focused on China and USA for several reasons; China is the country where the outbreak started, yet they managed to efficiently respond to the crisis with several strategies, this is clear in its very low infection spread rate and very high recovery rates (Saied, Metwally, Madkhali, Haque, & Dhama, 2021), (Covid-19 Cororona virus pandemic, 2022). America has one of the highest infection rates, probably due to the very high-test rates, yet the managed to have one of the highest recovery rates (Saied, Metwally, Madkhali, Haque, & Dhama, 2021), (Covid-19 Cororona virus pandemic, 2022).

2. The Need for Alternative care sites and its definition

The availability of inpatient care is indicated in the ratio of hospital beds to population; hospital beds considered include both public and private beds. It is typically calculated per 1000 people in a population (Landry, 2012). The number of beds in Egypt per 1000 persons in 2018 is 1.36, which is low when compared to the world's average of 2.7 beds/1,000. Taking in to consideration that the number of beds is 4.8 beds/1,000 in China, and 2.9 beds/1,000 in the United States (capmas, 2018), (Hospital beds, 2019), (Albert, Ahmed , & Helal , 2017). With the low number of hospital beds per population, the growing population each year, and unexpected disasters such as pandemics appears the demand for more hospital beds to serve the surge capacity. But on the other hand, excess bed capacity results in additional costs and stagnant capital. As a result, appears the importance of alternative care sites to address possible capacity and capability shortages and gaps in healthcare systems. (Ravaghi, Alidoost, Mannion, & B elorgeot, 2020), (Cogley, 2020), (Meyer, Blanchfield, Bohmer, James , & Vanderwagen, 2020).

Alternate care site according to ASHE (The American Society for Health Care Engineering), FEMA (Federal Emergency Management Agency) and the CDC (Centers for Disease Control); An Alternate Care Site (ACS) is any building or structure that is not currently being used for health care but is temporarily converted or built for health care use during an urgent need in capacity to provide additional capability for an affected community outside the walls of a health care facility (Converting alternate care sites to patient space options, 2021), (Meyer, Blanchfield, Bohmer, James , & Vanderwagen, 2020).

An ACS can be established in many types of buildings or structures of opportunity including Open Bay structures and Closed room structure (Converting alternate care sites to patient space options, 2021), (AIA, 2020). Open bay structures are like National Guard armories, gymnasiums, sports centers, schools, health clubs (only if equipment can be moved/removed), and convention centers. While Closed room structure are like hotels, dormitories, ships, and modular units within proximity to hospital systems (Madison, 2020).

To be regarded a fully functional ACS, it must include the facility (the space), appropriate staffing, medical equipment, health-care-delivery supplies (the service), and strong communication and coordination network that facilitates the easy transfer of patients within a community as needed for care delivery (Madison, 2020), (Elrod & Fortenberry, 2017), (Organization, 2014), (Meyer, Blanchfield, Bohmer, James , & Vanderwagen, 2020).

3. Egyptian, Chinese, and American successful response actions

Many factors affected the response actions of countries. Community's vulnerability whether physical, economic, social, or environmental affected time for controlling the situation and led to variation in terms of speed, scale, and intensity of interventions. Also, countries' previous experiences, the population understanding of the situation and willingness to participate in dealing with the disaster affected response actions (Madhav, et al.), (AIA, 2020).

The researcher held a comparison between the three countries in **Table 1** concerning several aspects, to understand their healthcare preparedness and response actions success (Saied, Metwally, Madkhali, Haque, & Dhama, 2021), (Covid-19 Cororona virus pandemic, 2022).

Table 1: Comparison between Egypt, China and USA by researcher based on (Saied, Metwally, Madkhali, Haque, & Dhama, 2021), (Covid-19 Cororona virus pandemic, 2022).

Country	Egypt	USA	China
Population	105,981,201	334,670,557	1,439,323,776
Hospitals bed	1.36 beds/1,000	2.9 beds/1,000	4.8 beds/1,000
Tests number	3,693,367	1,022,984,286	160,000,000
Tests rate	3.48%	305.66%	11.12%
Number of patients	515,645	85,241,016	223,605
Infection rate	0.49%	25.47%	0.0015%
Deaths	24,613	1,029,524	5,224
Death rate	4.77%	1.20%	2.34%
Recovered cases	442,182	81,764,911	214,682
Recovery rate	85.75%	95.92%	96.00%
Mean age	25 years	38 years	38 years

The statistics shown in the table, shows the shortage of inpatient care in Egypt, indicated in the ratio of hospital beds to population (Landry, 2012). It is 1.36 beds/1,000, which is lower than the world’s average 2.7 and also lower than that of USA and China (Saied, Metwally, Madkhali, Haque, & Dhama, 2021), (Covid-19 Cororona virus pandemic, 2022).

Infection rates identified is based on test rates. If the test rate is high, this indicates the effective surveillence, better situation assessment, and more credibility of the infection rate value. Infection rates is Egypt is lower than that of USA. This doesn’t necessarily mean that Egypt’s situation is better, it is probably due to the low-test rates, and the young age of populations (Han, et al., 2020), (Saied, Metwally, Madkhali, Haque, & Dhama, 2021), (Covid-19 Cororona virus pandemic, 2022). Death rate in Egypt is higher than that of USA and China, probably due to the low-test rates, which mostly were focused on serious cases, who have lower chance of survival. Same for recovery rates which is the lowers in Egypt too compared to the other two countries (Han, et al., 2020), (Saied, Metwally, Madkhali, Haque, & Dhama, 2021), (Covid-19 Cororona virus pandemic, 2022).

It is worth highlighting that China has one of the lowest infection rates (0.0015%) despite being the country where outbreak started. These rates mean they handled the pandemic efficiently with powerful quick responses. Also, America had test rates of 305.66%, which is very high, indicating the effective surveillence and better situation assessment (Saied, Metwally, Madkhali, Haque, & Dhama, 2021), (Covid-19 Cororona virus pandemic, 2022).

3.1 The Egyptian response actions

The government allocated hospitals to be used as isolation hospitals, then fever and chest disease hospitals were used with the increasing number of patients, the need for more capacity urged the government to allocate more hospitals to be used as isolation hospitals, for each governorate to have at least one in each (Abdel-Moneim & Rizk, 2020), (Hassan, 2020).

Despite the exerted efforts, the number of cases continued to increase causing an unprecedented pressure on the public medical sector, until it reached its maximum capacity. The government accordingly allocated more hospitals and established alternative care sites (Kamel & Mousa, 2020), (Hassan, 2020).

The private sector provided hotels to be used as quarantine stations, like what happened in Marsa Allam where Egyptians coming from outside Egypt had to stay for 14 days before getting back to their families to prevent cross infection (Soliman, 2020), (Kamel & Mousa, 2020), (Hassan, 2020).

Egypt also established field hospital in dorms and universities to serve non-acute patients, like in Ain Shams university field hospital. It is established over an area of 4,600 square meters, to include 200 beds, including 11 intensive care (ICU) beds and 16 beds for medical staff (Egypt establishes first field hospital to treat coronavirus cases: official, 2020).

One of the biggest response actions Egypt planned was the hospital established by Egyptian Armed forces, at Al Manara International Conference Centre in New Cairo. The hospital consists of 4,000 beds. 3000 of them are placed in four exhibition halls inside the Conference Centre and 1000 in five field hospitals. The project included ICU ambulances, radiology department, lab, and surgical units (Tawil, 2020).

In some governorates, citizens criticized and condemned the selection choice of isolation hospital for several reasons, one of them is that the selected hospital was the only hospital that served them, the other is that it is close to their residential areas and the last one is that some of the hospitals were not medically equipped with the needed tools and equipment to host covid patients (Abdel-Moneim & Rizk, 2020).

3.2 The Chinese response actions

Pandemics' responses are highly affected by past experiences, where China has witnessed and lived through outbreaks in the last hundred years. Accordingly it is more ready and capable of prompt responses, as they invested in the healthcare and public-health infrastructure, also the public were more ready to cooperate with invasive surveillance and strict rules, trading-off between their personal rights and public good than USA and Egypt (Madhav, et al.), (AIA, 2020).

The corona virus 2 (SARS-CoV-2) disease's first case was identified in December 2019, in Wuhan the capital of Hubei province in China. The Chinese adopted the covid zero policy which is isolating all cases, regardless of severity (Xiadong, 2021), they worked on early testing, meticulous surveillance, and tight isolation of patients and connections (Peng, et al., 2020). China has used three main strategies to admit people for treatment since the COVID-19 outbreak: designated hospitals, newly built temporary hospitals, and Fangcang shelter hospitals (Fang, et al., 2020).

3.2.1 Designated hospitals

They are regional infectious disease hospitals that the Chinese government repurposed for the COVID-19 pandemic response (Li, Wang, Wang, & Lu, 2021).

It is considered an acute care alternative care site model (Madison, 2020), this model serves patients with severe or critical symptoms, as it has enough resources for extensive tasks that help providing accurate diagnosis and greater levels of medical treatment (Li, Wang, Wang, & Lu, 2021).

There are three characteristics that make them efficient at reducing COVID-19. First, the centralized reaction and action system, which comprises centralized patients, experts, and resources, second, the massive capacity and extensive functions and last, the Closed-loop management system by limiting or eliminating patient transfers inside the hospital (Li, Wang, Wang, & Lu, 2021). This model is used when epidemic is under control (Li, Wang, Wang, & Lu, 2021).

An example of designated hospitals is Shanghai Public Health Clinical Centre (SPHCC) with total capacity 1987 beds, 527 beds in negative-pressure rooms, 600 beds for high-level medical care, especially for those in critical conditions, and 860 makeshift beds in emergency wards (Li, Wang, Wang, & Lu, 2021). They are originally infectious disease hospitals, so zoning is the same with some minor changes to adapt to the situation (Li, Wang, Wang, & Lu, 2021).

The alterations required are moderate ones with moderate cost and the time taken for conversion and operation is relatively short (Madison, 2020), (Li, Wang, Wang, & Lu, 2021).

3.2.2 Newly built temporary hospitals

A temporary hospital that fulfils the standards of respiratory infectious disease hospitals, built by collective efforts of thousands of workers (Huoshenshan Hospital Construction, 2020), (Li, Wang, Wang, & Lu, 2021). The structure is made up of prefabricated hospital components. Each bedroom is built off-site with material like aluminum and steel, then delivered to the job site to plug in and stack up. Designers took inspiration from designated hospital built in 2004 due to SARS outbreak, but due to terrain and design conditions, they had to start the design from scratch (Huoshenshan Hospital Construction, 2020).

It is considered an acute care alternative care site model (Madison, 2020), this model serves patients with severe or critical symptoms (Chen, Yang, Peng, & Wang, 2021). There are three characteristics that make them efficient at reducing COVID-19; rapid construction, collective work, and high tech represented in systems and pre-fabrication (Huoshenshan Hospital Construction, 2020). This model is used when an epidemic is getting out of control, as patients' number reached or exceeded the capacity of the local healthcare system (Li, Wang, Wang, & Lu, 2021).

An example of newly built temporary hospitals is Huoshenshan Hospital with total capacity 1000 beds and Leishenshan Hospital with total capacity 1500 beds. Both in rooms configuration plan. The Huoshenshan Hospital is based on 5 functions, main hospital building, ICU building, supporting functions, staff residential buildings and medical technology building as shown in **Figure 1** (Li, Wang, Wang, & Lu, 2021), (Huoshenshan Hospital, 2021).

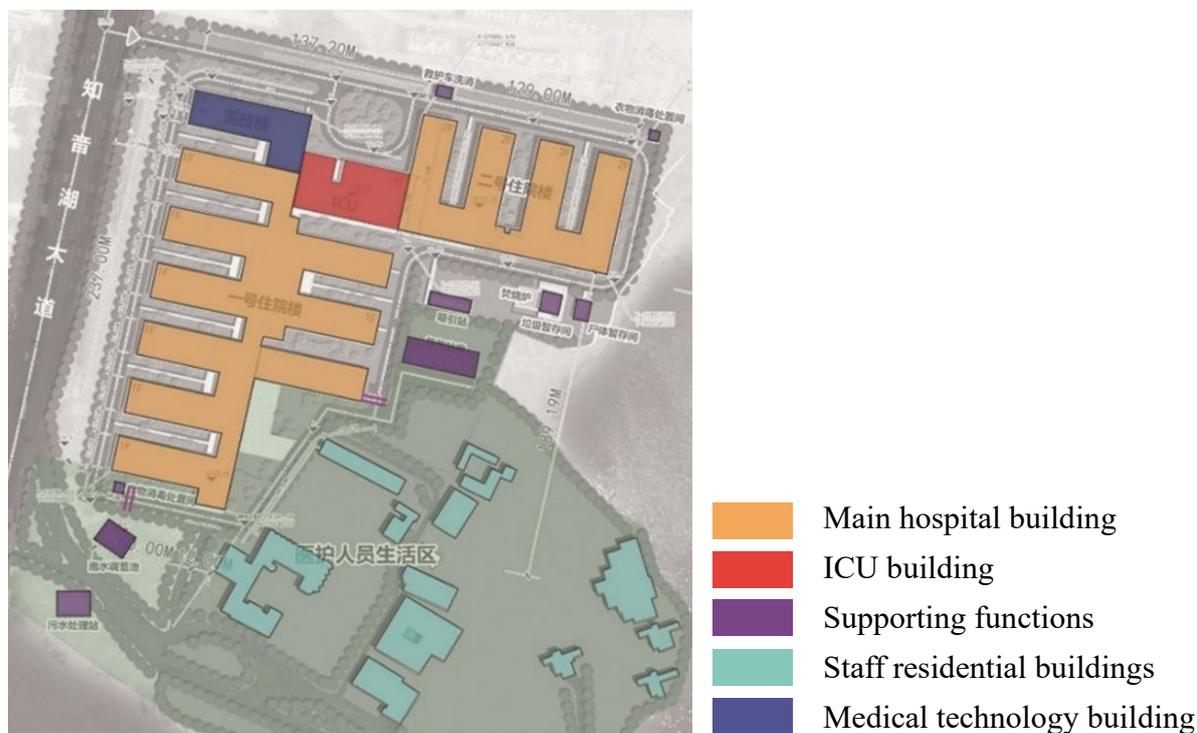


Figure 1: Newly built temporary hospitals, source: (Huoshenshan Hospital, 2021).

The Main hospital building is divided to four zones: clean zone, Semi-contaminated zone, Contaminated zone, and Hygiene passing and buffer zone (Huoshenshan Hospital, 2021). The ways the virus spreads affected how they designed the hospital in order to prevent cross-infection, the layout has different wings where patients with differing levels of contagiousness can be confined in different wings according to triage (Huoshenshan Hospital Construction, 2020), (Huoshenshan Hospital, 2021). Medical professionals utilize the corridor that run down the middle of the hospital and patients use the peripheral corridors (Huoshenshan Hospital Construction, 2020). Added here the zoning of the ground floor plan of Huoshenshan Hospital as shown in **Figure 2**.

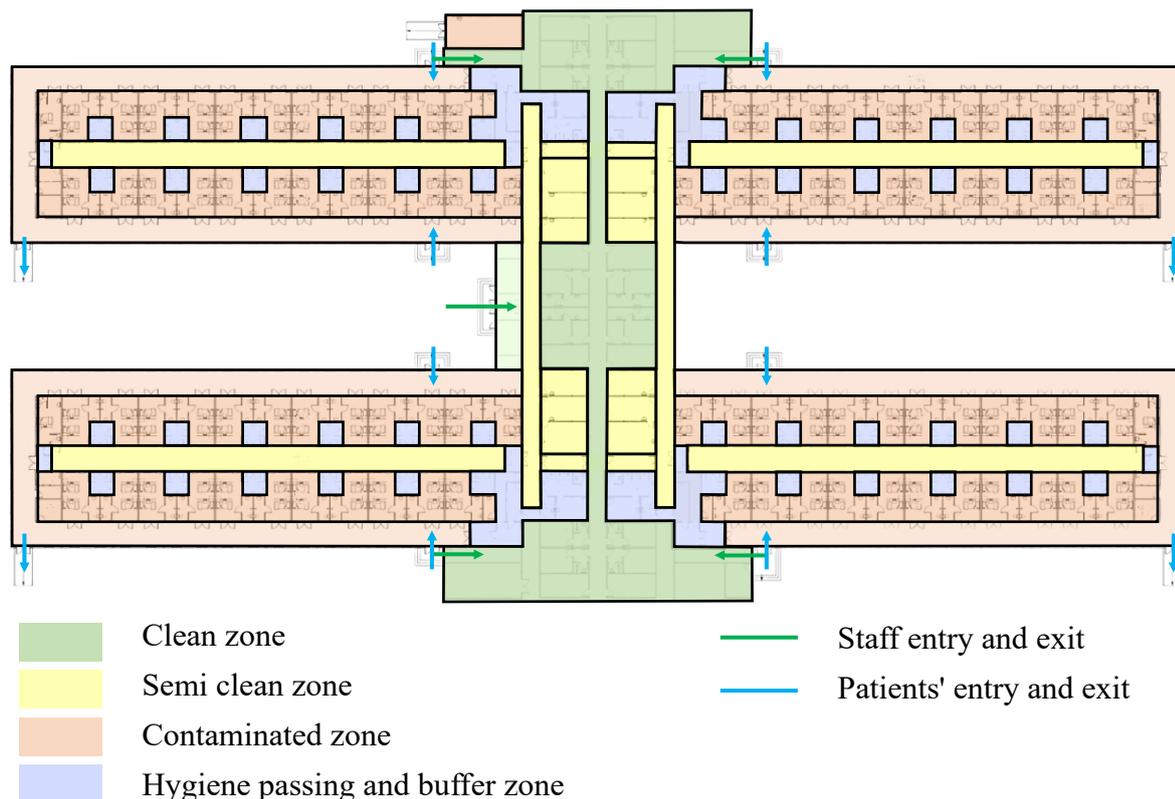


Figure 2: Huoshenshan Hospital ground floor plan zoning, source: (Huoshenshan Hospital, 2021).

In this model, the construction starts from scratch using prefabricated units on vacant lands. Relatively it takes more time for set up than the other two Chinese models, but with the Chinese technology and collective work, it takes 9 to 12 days (Luo, Liua, Li, Chen, & Zhang, 2020). The construction costs more money than the other two models due to the speed and technology used.

3.2.3 Fangcang shelter hospitals

The effectiveness of COVID-19 control in China was largely due to the Chinese novel public health concept, the Fangcang shelter hospitals. It is based on the requisition of public venues, such as stadiums and exhibition centers, to be converted into healthcare facilities (Chen, et al., 2020), (Li, Wang, Wang, & Lu, 2021).

It is considered a non-acute care alternative care site model (Madison, 2020). This model serves patients with mild to moderate symptoms, as it is based on limited resources, with the aim of relieving stress on hospitals, to focus on severe and critical cases (Xiadong, 2021), (Chen, et al., 2020), (Li, Wang, Wang, & Lu, 2021). It was implemented to scale its capacity rapidly and massively, due to the insufficient hospital bed numbers, which led to thousands of mild to moderate covid-19 patients to be sent home for isolation. This approach aims to isolate those patients as home isolation was not desired. Home isolation cannot be firmly enforced due to the proved high intrafamily transmission rates. Also, organizing medical treatment, regular monitoring of illness development, and timely referral to hospital care for thousands of people is hard to handle (Chen, et al., 2020).

There are three characteristics that make them efficient at reducing COVID-19: rapid construction, massive scale, and low cost (Chen, et al., 2020). Its main functions are isolation, triage, basic medical care, frequent monitoring, rapid referral, essential living, and social engagement (Fang, et al., 2020).

Public venues are good choice due to their location in the center of large metro areas and at the core of urban areas, so when the epidemic hits, patients of the area head to it, so it helps in avoiding patients' concentration which may lead to cross-infection, also due to its adjacency to multiple major arterial roads, close distance to traditional hospitals. Public venues design have several advantages, one of them is having Spacious outdoor area that facilitates entry and evacuation of a large number of people and vehicles, the construction of temporary auxiliary tents, and the installation of medical facilities, the other is having Spacious indoor space as most of these structures are long-span structures with flat space which can accommodate people and equipment and can be easily renovated and partitioned to provide essential living conditions for a surge of infected patients during a pandemic. Also, the power supply is reliable and easy to be remodeled as they often hold big events. One of the challenges of being located at the core of urban areas is the short distance to high-density residential areas, schools and other densely populated areas posing the risk of virus transmission (Fang, et al., 2020). This model is used when epidemic is out of control, and developing rapidly, and number of patients exceeds the capacity of the local healthcare system (Li, Wang, Wang, & Lu, 2021).

In Wuhan city, areas ranged from 2000 m² in Wuhan International sports center to 127,000 m² in Wuhan International Convention and Exhibition Centre. So, the capacity varied accordingly in each case and according to the community need and the available public venues (Fang, et al., 2020).

The zoning of Fangsang shelter hospitals is divided in to four zones: clean zone, Semi-contaminated zone, Contaminated zone, and Hygiene passing and buffer zone as shown in **Figure 3** (Fang, et al., 2020).

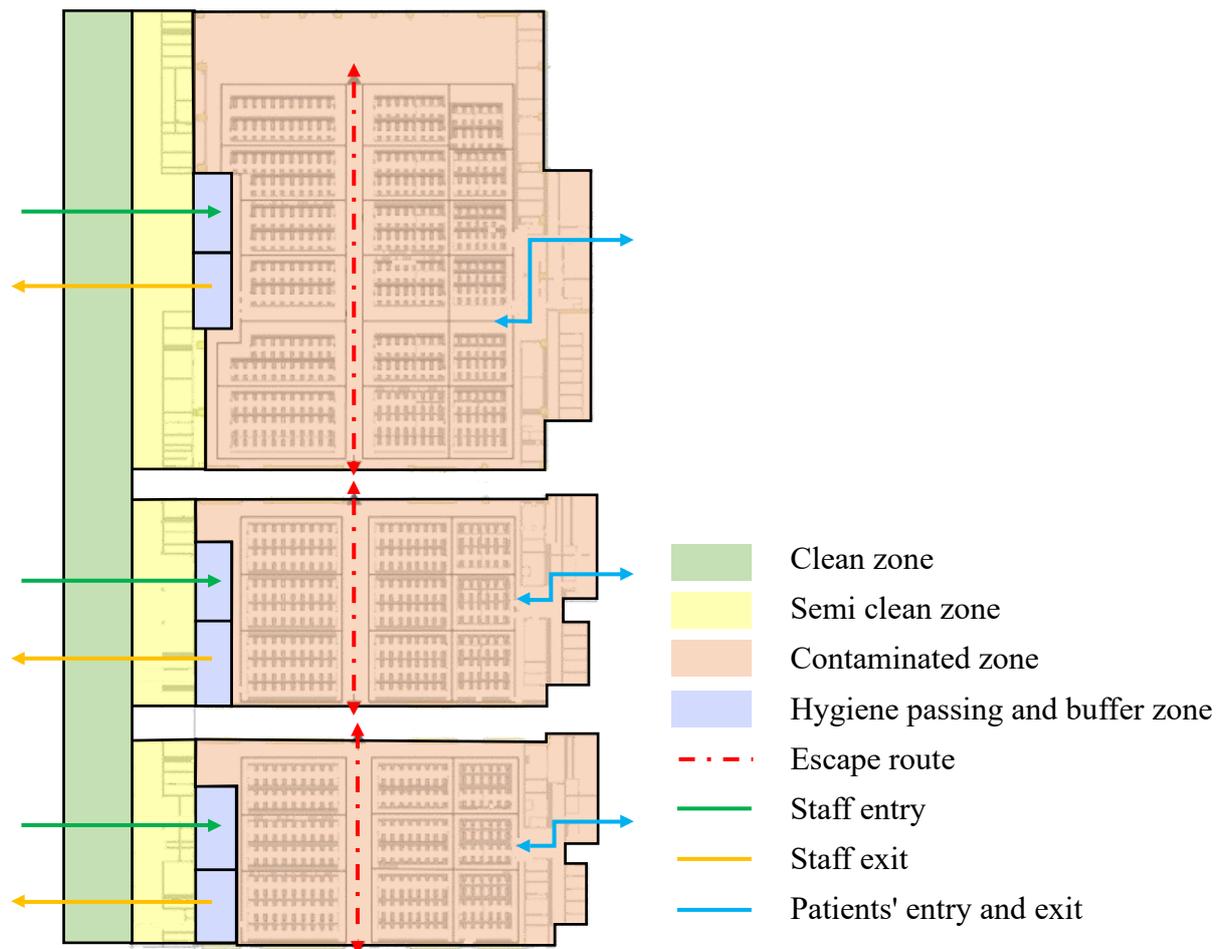


Figure 3: Fangsang shelter hospital zoning by researcher based on (Fang, et al., 2020).

The fangsang shelter hospital targets mild to moderate cases, so it required minor modifications. Accordingly, it requires accordingly low cost and short time for conversion (Fang, et al., 2020).

3.3 The American response actions

The United States government published an alternate Care Site toolkit to help address potential capacity and capability gaps in the health care systems during the COVID-19 pandemic. They introduced three models for ACSs: Non-Acute Care ACS Model, Hybrid Care ACS Model, and Acute Care ACS Model (Madison, 2020). They also introduced several concepts; Hotel to Healthcare Concept H2HC, Arena to Healthcare Concept A2HC, and Tent Camp to Healthcare Concept T2HC (Performance Work Statement (PWS) Convert a Hotel into a Temporary Alternate Care Site, COVID Non-Acute, 2020).

3.3.1 Hotel to Healthcare Concept H2HC

There are three conceptual proposals for hotel conversion to alternative care site proposed by USACE and ASHE (USACE U. A., 2020), (Performance Work Statement (PWS) Convert a Hotel into a Temporary Alternate Care Site, COVID Non-Acute, 2020), (Schroer, Shelton, & Evans, 2020). USACE suggested two conceptual alternatives for the same building, one to provide non-acute care and the

other to provide acute care. Non acute care model serves patients with mild to moderate symptoms, while acute care model serves patients with severe or critical symptoms (USACE U. A., 2020), (Performance Work Statement (PWS) Convert a Hotel into a Temporary Alternate Care Site, COVID Non-Acute, 2020). ASHE suggested a hybrid care model, it serves patients with mild to moderate symptoms and also some acute COVID-19 patients in transition to a medical facility that supports higher acuity care (Schroer, Shelton, & Evans, 2020).

Hotels are a good choice due to the abundance of unoccupied hotel rooms in practically every large city suggests a potential solution to the shortage of hospital beds, the presence of single patient rooms with negative pressure isolation and private toilets to satisfy infection control standards, The opportunity for isolation per floor, The hotel's infrastructure has several fire and life safety features, Its spaces and space configuration allow the conversion, the availability of on-site food service (Hornick & Glick, 2020), (Schroer, Shelton, & Evans, 2020).

Non-acute, acute and hybrid care models are used when the epidemic is getting out of control. It is used to satisfy needed capacity in case of non-acute care model, to provide capability by providing ICU units in case of acute care model and to satisfy both needed capacity and capability in case of hybrid care model (Performance Work Statement (PWS) Convert a Hotel into a Temporary Alternate Care Site, COVID Non-Acute, 2020), (Performance Work Statement (PWS), Convert a Hotel into a Temporary Alternate Care Site (ACS), COVID Acute, 2020) (Schroer, Shelton, & Evans, 2020).

Non acute model requires minor modifications; accordingly, it requires low cost and short time for conversion. While acute care model requires significant modifications; accordingly, it requires relatively higher cost and longer time for conversion (Performance Work Statement, Converting Hotels into Temporary Alternate Care Sites (ACS), Acute care, 2020). Hybrid care model requires moderate modifications, accordingly moderate cost and average time for conversion (Schroer, Shelton, & Evans, 2020).

A. USACE acute and non-acute conceptual proposals

For both acute and non-acute care model, the applied concept is Clean one side and dirty the other side (USACE U. A., 2020), (Performance Work Statement, Converting Hotels into Temporary Alternate Care Sites (ACS), Acute care, 2020).. The ground floor is all clean, for staff and central support areas with Staff needs (Doctors, nurses and administrative), clean Service, and clean Storage. So, staff can move freely on the ground floor. Upper floor levels will be considered dirty zones specified for infected patients/ treatment. In non-acute model patient rooms are not preferred to be placed in the ground floor (Performance Work Statement (PWS) Convert a Hotel into a Temporary Alternate Care Site, COVID Non-Acute, 2020), while in the acute care model patient rooms should not be positioned on the ground floor (Performance Work Statement, Converting Hotels into Temporary Alternate Care Sites (ACS), Acute care, 2020).

For Vertical circulation, a stairway will be labelled as clean and the other one will be classified as dirty, with each at opposing ends of the building. The clean one is for

vertical circulation for staff to serve patients and the dirty one is for patients and for waste transfer to the ground floor to be disposed. For elevators: If just one elevator is available, it must be used as dirty for transporting patients to upper floors. Second or third elevators might be used for additional purposes, as clean or dietary services (optional) (Performance Work Statement (PWS) Convert a Hotel into a Temporary Alternate Care Site, COVID Non-Acute, 2020).

Acute care model needs more area for more critical care needs like in nursing stations, medical storage and medical gas storage. Another difference between them is that in non-acute care model, isolation is by floor or zone, while in the acute model each room is negative pressure to the corridor (Performance Work Statement (PWS) Convert a Hotel into a Temporary Alternate Care Site, COVID Non-Acute, 2020), (Performance Work Statement, Converting Hotels into Temporary Alternate Care Sites (ACS), Acute care, 2020).

The total capacity in ground and first floor in acute care model is 24 rooms including 2 ICU rooms, while non-acute care model it is 18 room (Performance Work Statement (PWS) Convert a Hotel into a Temporary Alternate Care Site, COVID Non-Acute, 2020). It is not clear in any source the number of floors of the used hotel building, but each typical floor will include 18-22 rooms according to available drawings.

The zoning of non-acute care model is shown in **Figure 4** (USACE U. A., 2020), (Performance Work Statement (PWS) Convert a Hotel into a Temporary Alternate Care Site, COVID Non-Acute, 2020).



Figure 4: Ground and typical floor plan zoning by researcher based on (Performance Work Statement (PWS) Convert a Hotel into a Temporary Alternate Care Site, COVID Non-Acute, 2020).

The zoning of acute care model as shown in **Figure 5** (Performance Work Statement (PWS), Convert a Hotel into a Temporary Alternate Care Site (ACS), COVID Acute, 2020).



Figure 5: Ground and typical floor plan zoning by researcher based on (Performance Work Statement (PWS), Convert a Hotel into a Temporary Alternate Care Site (ACS), COVID Acute, 2020).

B. ASHE proposal hybrid care conceptual proposal

In this model, there is a separation in entry and circulation between staff and covid-19 suspects or positive cases, only positive covid-19 patients are allowed to enter the hotel for their condition to be assessed inside. If the case turned out to be ambulatory, then patients are sent to hotel guest rooms that are prepared as patient rooms to be under observation, if the patient’s condition worsens, patients are moved to higher acuity ward (ballroom) for direct observation and immediate care. If the condition worsens and there is a need for ventilation or other necessary hospital-based

treatments, then patients are sent to hospitals to get required care (Schroer, Shelton, & Evans, 2020).

For circulation there are 2 Staff/service elevators, and 6 elevators for patients. Its total capacity is 398 beds, 110 in wards and 288 in rooms. Also, accommodation capacity for Staff is planned for 150 persons (Schroer, Shelton, & Evans, 2020).

The zoning of the ground, first and typical floor is shown in **Figure 6** (Schroer, Shelton, & Evans, 2020).



Figure 6: Ground, first and typical floor plan zoning by researcher based on (Schroer, Shelton, & Evans, 2020).

3.3.2 Arena to Healthcare Concept A2HC

The concept is based on the requisition of public venues, such as stadiums and exhibition centers, to be converted into healthcare facilities that function as a satellite patient ward, with a nearby full-service hospital to provide support like logistics, materials and trash management, and nutrition care (USACE, Performance Work Statement (PWS): Convert a Convention Center into a Temporary Alternate Care Site (ACS), COVID Non-Acute , 2020).

USACE proposed three models: non acute, hybrid, and acute care model. Non acute care model serves patients with mild to moderate symptoms, hybrid care model serves also patients with mild to moderate symptoms in addition to some acute COVID-19 patients in transition to a medical facility that supports higher acuity care Acute care model serves patients with severe or critical symptoms (USACE, Performance Work Statement (PWS): Convert a Convention Center into a Temporary Alternate Care Site (ACS), COVID Non-Acute , 2020).

There are three characteristics that make them efficient at reducing COVID-19. First, it allows hosting large number of patients, also the configuration allows for a reduction in the number of healthcare workers needed, second, the short construction period needed and last, Greater use of prefabricated construction (USACE, Performance Work Statement (PWS): Convert a Convention Center into a Temporary Alternate Care Site (ACS), COVID Non-Acute , 2020).

Non-acute, acute and hybrid care models are used when the epidemic is getting out of control. It is used to satisfy needed capacity in case of non-acute care model, to provide capability by providing ICU units in case of acute care model and to satisfy both needed capacity and capability in case of hybrid care model (USACE, Performance Work Statement (PWS): Convert a Convention Center into a Temporary Alternate Care Site (ACS), COVID Non-Acute , 2020).

Non acute model requires minor modifications; accordingly, it requires low cost and short time for conversion, while acute care model requires significant modifications; accordingly, it requires relatively higher cost and longer time for conversion, and hybrid care model requires moderate modifications, accordingly moderate cost and average time for conversion (USACE, Performance Work Statement (PWS): Convert a Convention Center into a Temporary Alternate Care Site (ACS), COVID Non-Acute , 2020), (USACE, A2HC Covid Actue- Performance Work Statement, 2020).

The main zoning of non-acute care model is shown in **Figure 7**. It consists of contaminated zone presented in the patients' area, semi contaminate zone presented in patient and staff toilet and other support spaces, hygiene passing and buffer zone for donning and doffing between clean one and semi contaminated zone and the last zone the clean zone where there is Laundry, staff lockers/shows, pharmacy, dinning, break team room, and morgue (USACE, Performance Work Statement (PWS): Convert a Convention Center into a Temporary Alternate Care Site (ACS), COVID Non-Acute , 2020), (USACE, A2HC Covid Actue- Performance Work Statement, 2020).

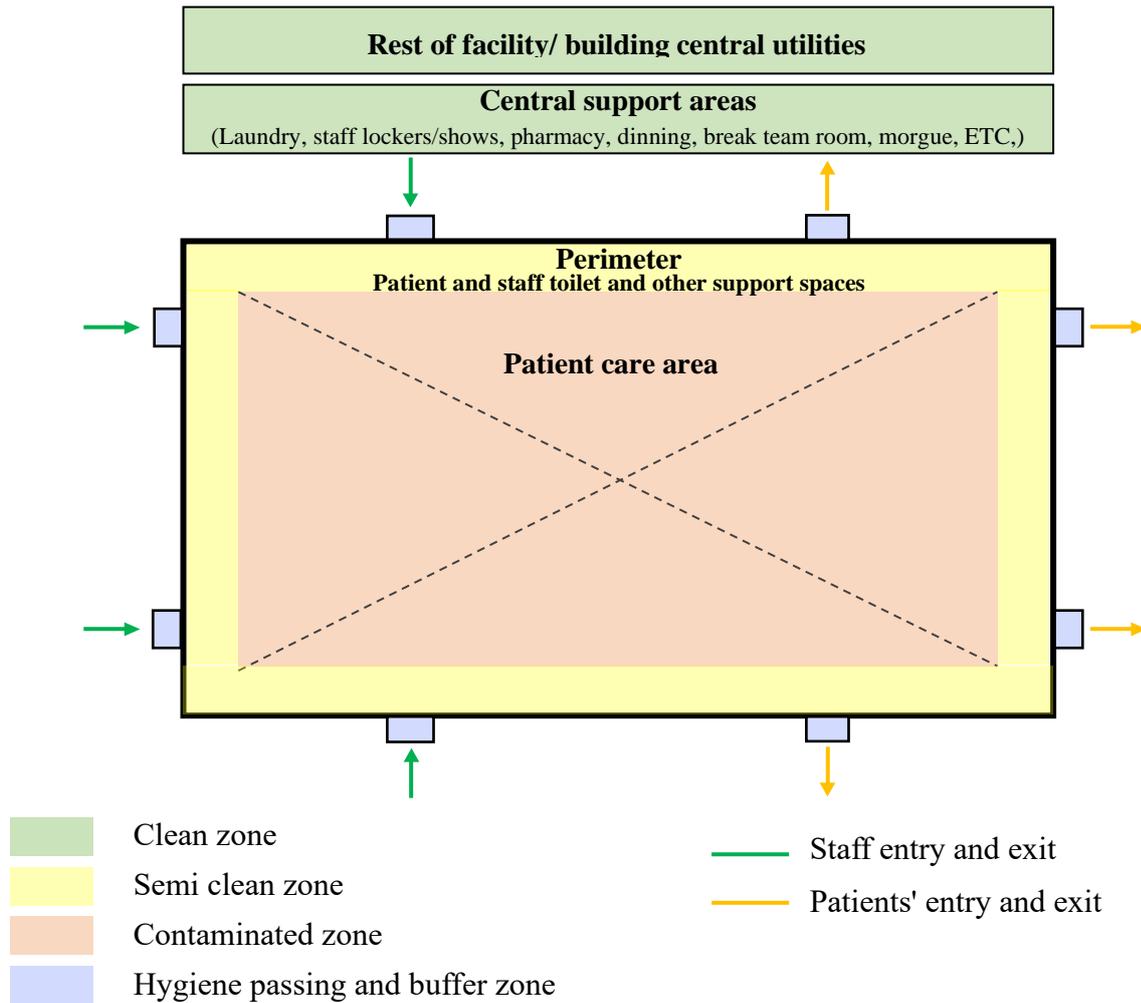


Figure 7: Non acute, hybrid care model zoning, source: (USACE, Performance Work Statement (PWS): Convert a Convention Center into a Temporary Alternate Care Site (ACS), COVID Non-Acute, 2020).

The patient zone area is a 100*50 m², it serves in case of the non-acute care model in this case 288 patients, a part of it can be converted to serve patients who need acute care according to community’s need as shown in **Figure 8**.



Figure 8: Acute patient area in hybrid care model by researcher, Source: (USACE, Performance Work Statement (PWS): Convert a Convention Center into a Temporary Alternate Care Site (ACS), COVID Non-Acute , 2020).

This is the main zoning of acute care model is shown in **Figure 9**, in this model all rooms are negatively pressured, and all functions are included in each block rather than in the periphery like in previous cases (USACE, A2HC Covid Acute-Performance Work Statement, 2020).

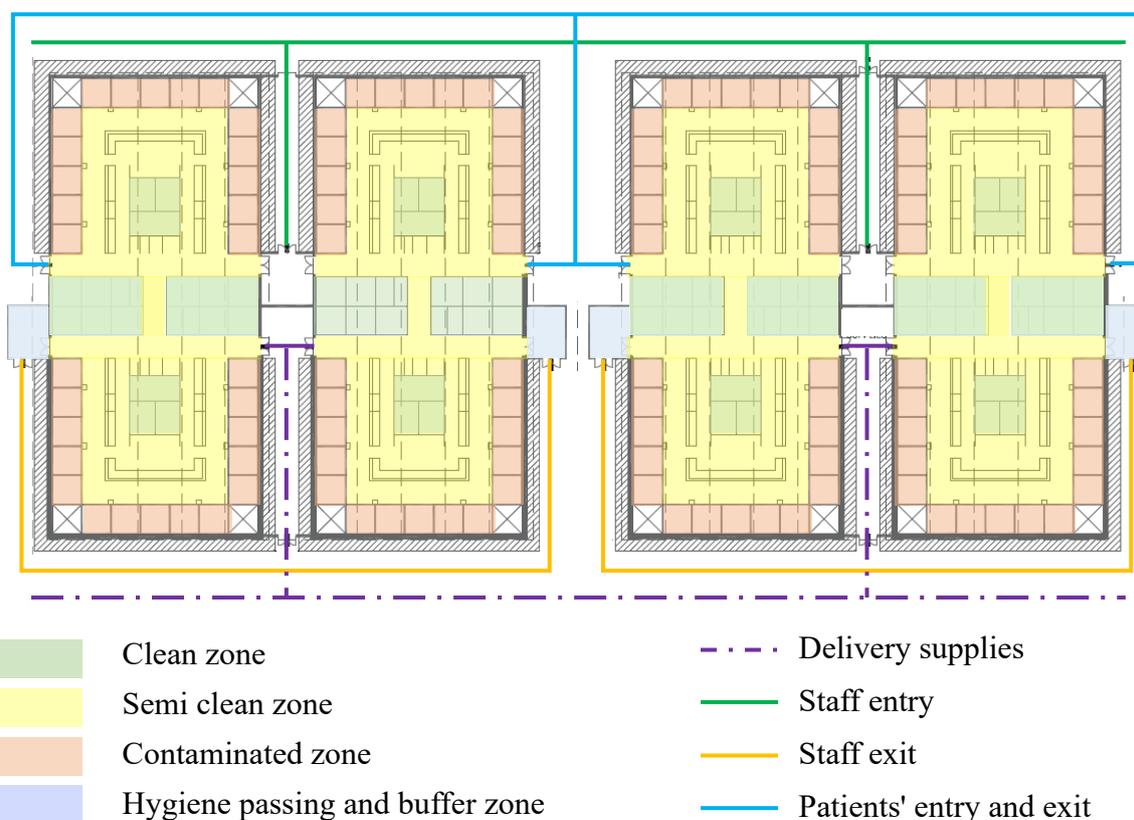


Figure 9: Acute care model zoning by researcher based on (USACE, A2HC Covid Acute-Performance Work Statement, 2020).

This conceptual proposal here is of area 90*50 meters and it serves 60 patients with severe symptoms (USACE, A2HC Covid Actue- Performance Work Statement, 2020).

3.3.3 Tent camp to Healthcare Concept A2HC

Tent camps are a very good alternative if proper hard-walled facilities are not available like in rural communities where arenas and hotels are not available, if there is needed additional capacity by hospitals, hospital's parking can be used and if there is needed additional capacity by the community, shopping centers' parking's and city parks can be used (Tent camps to healthcare concept (TC2HC) (Covid–non-acute) alternative care facility (ACF), 2020). They are usually located near to a hospital (within 10 miles) to be capable of providing acute care in case patients' condition worsens to provide after being transferred to the hospital.

This type of alternative care sites is non-acute alternative care site thar serves patients with mild to moderate symptoms (Tent camps to healthcare concept (TC2HC) (Covid–non-acute) alternative care facility (ACF), 2020), (USACE, Tent Camp to Healthcare Concept TC2HC, 2020).

It is characterized by rapid construction, independence leading to the ability to choose the location freely and high tech represented in systems and pre-fabrication. It is used when the situation is getting out of control especially in rural areas when waled structures are not available (USACE, Performance Work Statement (PWS): Convert a Convention Center into a Temporary Alternate Care Site (ACS), COVID Non-Acute , 2020).

In this model, the construction starts from scratch on vacant land, it requires average cost and relative short time for construction (USACE, Performance Work Statement (PWS): Convert a Convention Center into a Temporary Alternate Care Site (ACS), COVID Non-Acute, 2020). The basic designed model is to host 250 patients as in **Figure 10**, it can be repeated to host 500 or 1000 patients according to needed capacity and community need. Each of the 250-bed camps is divided into two 125-bed modules. Each module is entirely dedicated for either positive or negative covid-19 patients, but no mixing between them (Tent camps to healthcare concept (TC2HC) (Covid-non-acute) alternative care facility (ACF), 2020).



Figure 10: Tent camp conceptual zoning by researcher based on (Tent camps to healthcare concept (TC2HC) (Covid-non-acute) alternative care facility (ACF), 2020).

4. Conclusion

Planning for alternative care sites is crucial, as the normal healthcare capacity wouldn't be enough during pandemics and unfortunately based on history, pandemics are inevitable. Also, situation is worse in developing countries like Egypt where there are limited resources and more obstacles in the conversion process compared to developed countries, like in finding the suitable facility, appropriate staffing, medical equipment, health-care-delivery supplies, and strong communication and coordination network. A comparison is held in **Table 2** to show availability and applicability of these approaches in Egypt.

Table 2: Comparison between the Chinese and American response actions.

The republic of China			The United States of America		
Designated hospitals	Newly built temporary hospitals	Fangcang shelter hospitals	Hotel to Healthcare Concept	Arena to Healthcare Concept	Tent to Healthcare Concept
Origin					
Regional infectious disease hospitals	Vacant lands	Public venues	Hotel	Public venues	Vacant lands
Model type					
Acute care model	Acute care model	Non acute care model	Non acute care model	Non acute care model	Non acute care model
			Acute care model	Acute care model	
			Hybrid	Hybrid	
Target patients					
Severe or critical covid-19 cases	Severe or critical covid-19 cases	Mild to moderate cases	Mild to moderate cases	Mild to moderate cases	Mild to moderate cases
			Severe or critical covid-19 cases	Severe or critical covid-19 cases	
			Mix of mild to moderate and severe	Mix of mild to moderate and severe	
Open bays or closed rooms					
Open bays and closed rooms	Closed rooms	Open bays	Closed rooms	Open bays	Open bays
			Closed rooms	Closed rooms	
			Both	Both	
Purpose					
Capacity and capability	Capacity and capability	Capacity	Capacity	Capacity	Capacity
			Capability	Capability	
			Capacity and capability	Capacity and capability	

Alterations					
Moderate alterations	Significant alteration	Minimal alterations	Minimal alterations	Minimal alterations	Moderate alterations
			Significant alterations	Significant alterations	
			Moderate alterations	Moderate alterations	
Cost budget					
Moderate cost	High cost	Low cost	Low cost	Low cost	Moderate cost
			High cost	High cost	
			Moderate cost	Moderate cost	
Establishment time					
Relatively long time	Relatively long time	Fast	Fast	Fast	Average
			Relatively long time	Relatively long time	
			Average	Average	
Availability in Egypt					
Available	Not available	Available	Not available	Available	Available
Applicability in Egypt if not available					
-	Not highly applicable	-	Applicable	-	-

The type of alternative care sites has to be planned based on the community need, whether capacity is needed for non-acute patients, capability for acute patients or hybrid for both.

China had three strategies to provide alternate care sites: designated hospitals, newly built temporary hospitals, and Fangcang shelter hospitals. The first two were designed to deal with acute cases and the third was designed to deal with non-acute patients.

America was different from China, as they didn't have a specific strategy to deal with one type of patients, they proposed several conceptual alternatives for the same building type, to serve non acute patients, acute patients or both. They proposed hotel to healthcare concept (H2HC), arena to healthcare concept (A2HC), and tent camp to healthcare concept (T2HC). H2HC and A2HC serve non acute patients, acute patients or both while the T2HC proposal served non-acute case.

China used ACSs in open bay structures for non-acute care and closed rooms structures for acute care, while America used open bay and closed rooms structures for both.

It is always preferred to provide each patient a separate room to guarantee protection from cross infection, privacy and required service quality, but country's resources would not always allow it. Resources can be presented in the available structures suitable for conversion to alternative care sites, available budget, and available medical staff to cover patients.

ACSs establishment time and budget are directly related to the modifications needed. So as the modifications increase, cost and establishment time increase.

Egypt used their fever and chest hospitals as the Chinese used designated hospital, but on a smaller scale, Egypt also used public venues at Al Manara International Conference Centre like the Chinese in fangsang hospitals and the Americans in A2HC. It was more like the Chinese approach as it was mainly designed to provide capacity for non-acute patients. They also used field hospitals similar to T2HC proposal in the vacant lands at Al Manara International Conference Centre. They used hotels but as quarantine stations and not isolation hospitals. The newly built hospitals were so popular in China, but due to the technology in prefabricated materials and the amount of collective work needed in short period of time, it was not established in Egypt or America.

It is recommended to allocate sites in different areas in Egypt, make a scenario for their conversion to be used as insurance plan in time of crisis. It is preferred to choose existing structures that have architectural, mechanical, plumbing and electrical capabilities to be easily converted to efficient alternate care site. The usage of hotels, arena and vacant lands are all applicable in Egypt, but the budget needed, the buildings' conditions and alignment with minimum hospital standard in different regions in Egypt will determine the efficiency of conversion to ACS. It is also recommended to make some modifications in codes for easy conversion in different building types, to be used as warm ACSs.

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