Community Care Facility—A Novel Concept to Deal With the COVID-19 Pandemic: A Singaporean Institution's Experience

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ABSTRACT

Context: The coronavirus disease 2019 (COVID-19) pandemic has placed a strain on health care systems worldwide. Many hospitals experienced severe bed shortages; some had to turn patients away. In Singapore, the widespread outbreak, especially among the dormitory-based population, created a pressing need for alternative care sites.

Program: The first massive-scale community care facility (CCF) was started in Singapore to address the pandemic. It served as a low-acuity primary care center that could isolate and treat COVID-19–positive patients with mild disease. This allowed decompression of the patient load in hospitals, ensuring that those with more severe disease could receive timely medical attention.

Implementation: Various groups from the private and public sectors, including health care, construction, security, hotel management, and project coordination, were involved in the setup and operations of the CCF. A large exhibition center was converted into the care facility and segregated into zones to reduce cross-contamination. State-of-the-art technological infrastructure for health management was used. Several paraclinical services were made available.

Evaluation: The CCF was a timely and robust response that fulfilled several crucial functions, including cohort isolation, triage, basic medical care, and timely reviews and escalation of patients. It placed a unique focus on promoting patient ownership, responsibility, and mental well-being. It was largely successful, with a low hospital transfer rate of 0.37%.

Discussion: The success of the CCF could be attributed to the use of a facility of opportunity, strong interorganizational and cross-sector cooperation, an integrated and robust clinical system, and clear communication channels. It allows for efficient resource utilization and is valuable in future pandemics with similar disease characteristics.

KEY WORDS: alternative care sites, community care facility, COVID-19, out-of-hospital treatment, pandemic

Globally, there are more than 12 million confirmed cases of coronavirus disease 2019 (COVID-19) and more than 500 000 deaths.[1] Health care systems worldwide continue to face an increasing strain on resources, requiring innovative means of using them effectively. The community care facility (CCF) was first used in Singapore while addressing the COVID-19 pandemic. It served as a low-acuity patient care site that had 2 main purposes: to transfer stable patients from hospitals, thereby decompressing hospitals and enhancing hospital capacity; and to provide primary care for patients with mild disease, allowing timely referrals to acute care hospitals as necessary. This article discusses the conception of the CCF, its essential functions, factors influencing success, and applications in future pandemics.

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The Need for Alternative Care Facilities in Singapore

With a population density of 7950 people per square kilometer, Singapore is the third most densely populated country in the world.[2] Of its 5.7 million inhabitants,[3] around 1.4 million are migrant workers from India, Bangladesh, China, and Southeast Asia. They are mostly employed in the construction,

manual labor, and housekeeping sectors. Around 200 000 of these workers live in 43 purpose-built dormitories across the island. Between 12 and 20 men bunk in each room and sleep close to each other. Toilet and shower facilities are shared, and meals are taken at communal areas.[4,5]

The CCF was a novel response to an increasing number of COVID-19 cases in Singapore. Notably, there was a shift from imported cases to dormitory-based clusters. When the first 2 cases among dormitory residents were reported, they formed just 0.2% of the total cases in Singapore. In only 13 days, when the CCF began operations, 548 cases had been reported among dormitory residents. They accounted for 26.0% of the local cases.[6] As testing continued, the number of COVID-19 cases among the dormitory-based population was expected to increase. At the time of writing, dormitory-based cases formed 94.3% of the local COVID-19 cases, with a prevalence of 13.17% among the dormitory-based population.[7] This proved a pressing need to create a large-scale community-based medical facility that could accommodate, treat, and monitor the large number of affected patients.

Many of the dormitory residents who had tested positive for COVID-19 were asymptomatic or had mild disease. They had been identified because of extensive testing in a bid to curb disease spread.[8] While home isolation could theoretically address hospital bed shortage, it was not ideal among the dormitory residents, given that dormitories are often overcrowded. Inadequate sanitation also increased the risk of disease spread.[9-12] Stratifying the patients and isolating those who had mild disease in the CCF were crucial to prevent hospital bed shortages. Studies have shown that among patients who developed severe disease, the median time to dyspnea ranged from 5 to 8 days; to acute respiratory distress syndrome, 8 to 12 days; and to intensive care unit admission, 10 to 12 days.[13-16] The period from day 7 to 13 of illness was deemed the most critical,[17] coinciding with when these patients with early illness would be monitored in the CCF. In addition, patients who remained well at day 14 of illness would have passed the critical phase of the disease and were likely to remain clinically stable in the period following. Thus, the quick transfer of these patients to the CCF would prevent overloading acute care hospitals.

Conception and Implementation of the CCF

Infrastructure

The Singapore EXPO Convention and Exhibition Center was chosen as the first mega-scale facility. It was highly suitable as an alternative care facility for various reasons.[18] First, it was a large air-conditioned indoor facility, consisting of 10 halls that could each hold up to 900 patients. Each hall had its own air-handling unit. The open concept allowed fuss-free conversion into a care facility, reducing construction time. Second, many existing utilities were present, including potable water, toilets, electricity, and Internet connection. Third, easy access to each hall was available via restricted-access roads, facilitating transfers while allowing strict traffic control. Four, on-site kitchen facilities could cater to the large numbers. Finally, the existing staff, who were trained in venue operations, and were familiar with the facility, assisted in the CCF. Minimal retraining was needed.

Halls were opened in succession after the former had reached maximum capacity. Three distinct zones with different personal protective equipment (PPE) requirements were set up: the clean, semi-clean, and dirty zones (Figure 1). The clean zone was an all-access area where the operations and administrative staff were based and where the command center, staff rest areas, and storage rooms were located. All personnel had to wear a surgical mask in this zone. The dirty zone was located within the halls and housed the patients. Full PPE, including an N95 mask, goggles, protective gowns, and shower caps, had to be worn in this area. Equipment that had been brought into the dirty zone could not be removed. Before leaving the dirty zone, the staff adhered to a strict protocol, including the doffing of protective gowns and caps, hand hygiene, and disinfection. The semi-clean zone was a buffer between the dirty and clean zones. It was a single passageway with restricted access at 2 points: one between the clean and semi-clean zones and another between the dirty and semi-clean zones. It was mandatory to wear an N95 mask and goggles here. Access was limited to health care workers, security staff, and managing agents. All had to pass through an antechamber equipped with a High-Efficiency Particulate Air (HEPA) filter when leaving the dirty zone, allowing heightened infection control (Figure 2).

The dirty zone had only 2 points of access: one for the staff, via the doffing area through the antechamber, and one for patients, via the admission area, with a wide berth to facilitate ambulance transfers. Various services and areas were demarcated (Figure 2). Hall space was partitioned into private cubicles housing 1 to 2 patients. Emergency call buttons were set up outside each cubicle. The sickbay had a resuscitation cubicle, with the majority of the medical personnel nearby. Computers-on-Wheels facilitated easy setup and flexible usage. A clear and accessible emergency escape passage was identified

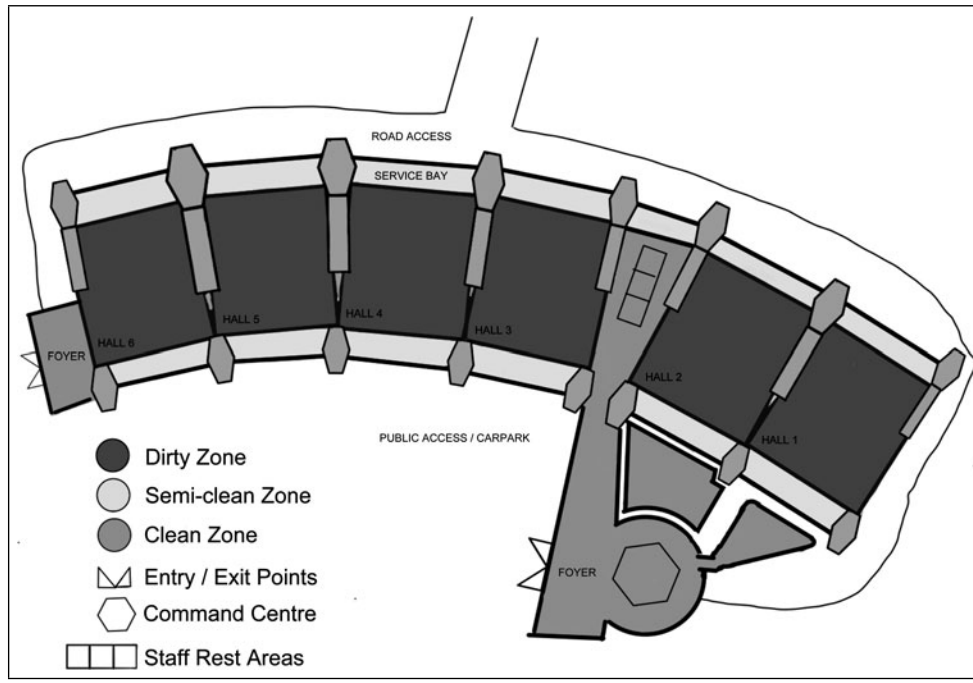

FIGURE 1 Aerial View of the Floor Plan of the EXPO Community Care Facility With the Clean, Semi-clean, and Dirty Zones Marked Out[a]
[a]Adapted from the EXPO floor plan by the Singapore EXPO and MAX Atria. Used with permission.

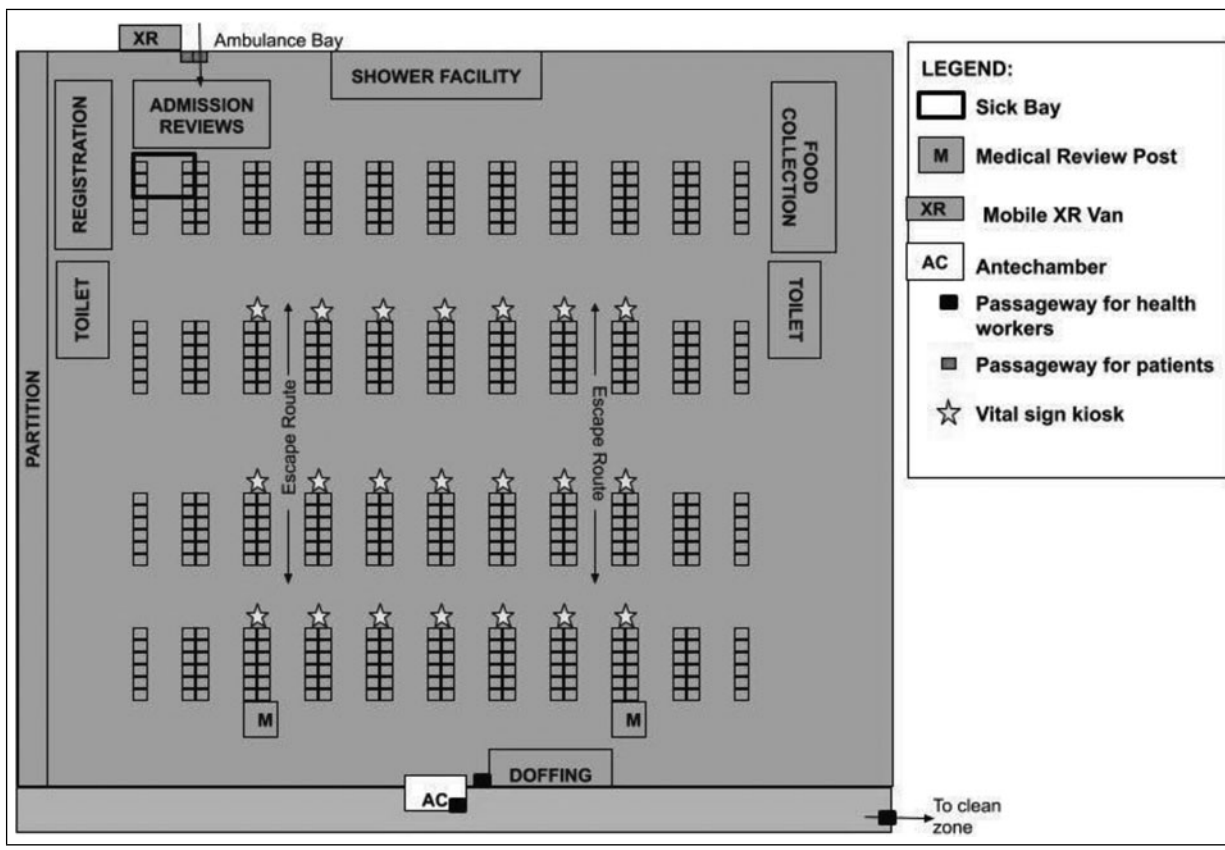

FIGURE 2 Detailed Floor Plan of a Hall in the EXPO, With Various Key Areas Highlighted
Abbreviation: XR, x-ray.

(Figure 2). Hall peripheries had emergency escape doors that could be opened as required.

Human resources, staffing, and logistics

Construction and project management were outsourced. The Ministry of Health (MOH) directed and laid out guidelines for the CCF's clinical operations. The MOH also advised on admitting criteria and patient eligibility and facilitated transfers between institutions.

Our institution, Woodlands Health Campus, was in charge of medical and nursing needs. The core team was a preformed group providing additional manpower in acute care hospitals while awaiting construction of a new hospital; therefore, they were readily available. Retired nurses, doctors, and other health care personnel from the private sector were actively recruited using the SG Healthcare Corps—an online recruitment portal. Integrated health information technology was adapted for on-site clinical support.

Auxiliary police provided security at access points, controlled human traffic, and responded to situations concerning the abscondment of persons under isolation. A resort and entertainment company was the managing agent responsible for operations and amenities within the facility.

All staff members underwent standardized training in donning and doffing of PPE. The staff worked on a 12-hourly shift system.

Patient care

Charting and prescribing were done on an adapted electronic clinical record system. This was linked to a nationwide computerized database to ensure continuity of care. Vital sign kiosks (Figure 2) and wearable smart devices routed readings to the electronic system, allowing tracking and flagging of abnormal entries.

Eligibility Criteria of the CCF

The CCF accepted patients in 2 stages of disease—those in the early phase of the disease (Figure 3), and those in the recovery phase (Figure 4). All patients had to fulfill the following criteria to be eligible for admission: (i) be independent in their activities of daily living; (ii) have no comorbidities requiring inpatient care, since such patients tend to have more

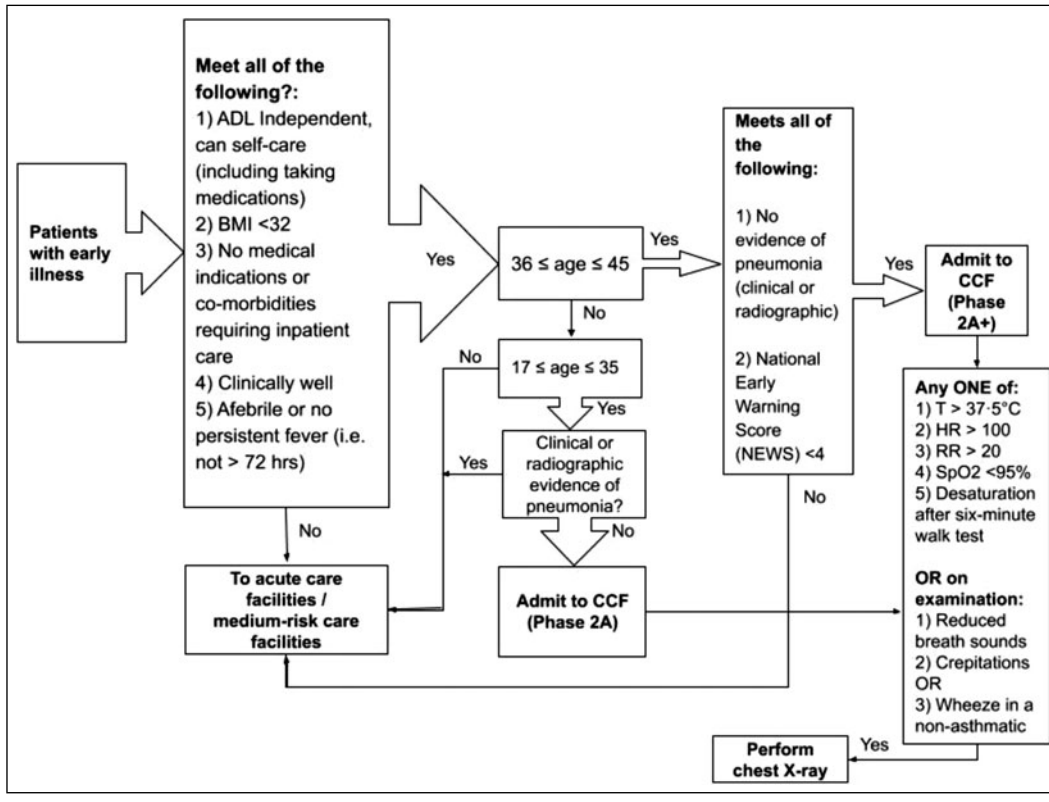

FIGURE 3 Stratification and Admission Pathway for Patients With Early Illness
Abbreviations: ADL, activities of daily living; BMI, body mass index; CCF, community care facility; HR, heart rate; RR, respiratory rate; Spo_2, pulse oximetry; T, temperature.

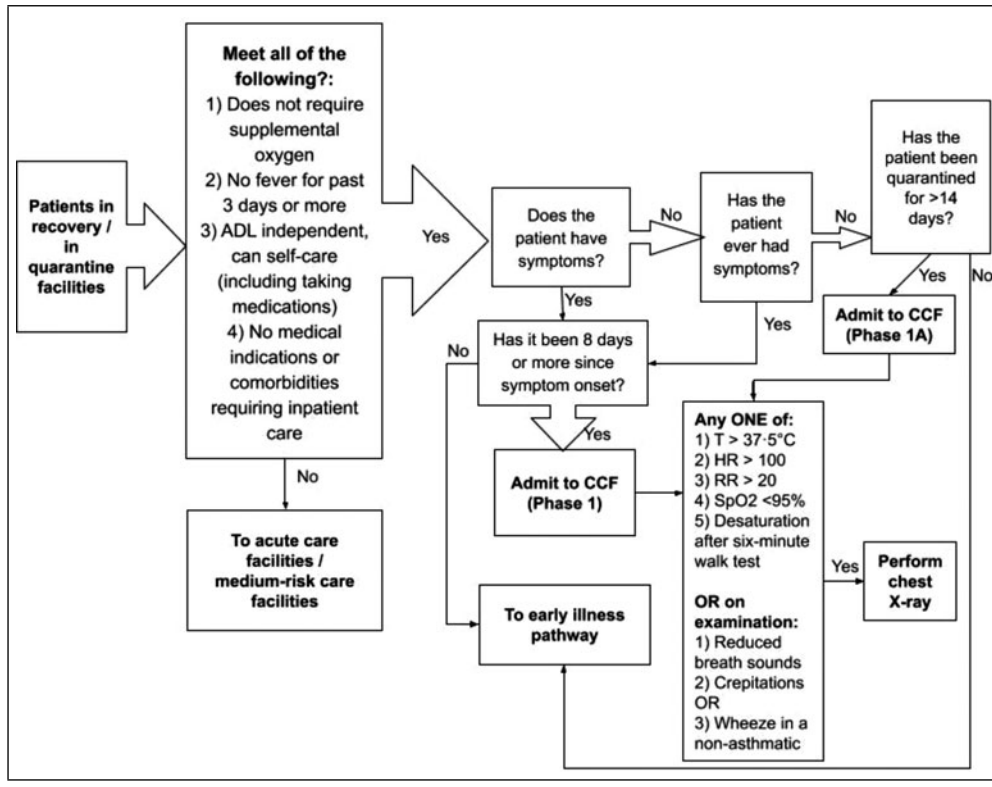

FIGURE 4 Stratification and Admission Pathway for Patients at Later Stage of the Disease
Abbreviations: ADL, activities of daily living; CCF, community care facility; HR, heart rate; RR, respiratory rate; Spo_2, pulse oximetry; T, temperature.

severe disease[14-16,19]; (iii) not relying on supplemental oxygen; (iv) have remained afebrile for at least the past 3 days. These were in keeping with recommendations for non–acute care alternative care sites.[20] Patients in the early stages of illness—whose symptoms had started less than 7 days prior—were only accepted if they were 45 years and younger, clinically well, and were not obese. Those aged 17 to 35 years were classified as phase 2A, and those aged 36 to 45 years were classified as phase 2A+. Patients whose symptom onset was 8 or more days before admission were classified as phase 1. They were admitted via the recovery pathway and deemed out of the critical phase. In addition, patients who were tested positive but remained asymptomatic, and had served the full quarantine order elsewhere, were also admitted under the recovery pathway, as phase 1A patients.

Key Functions of the CCF

Isolation

The CCF had several main functions: first, as an isolation venue. Cohort care of patients with COVID-19 in one facility helped reduce the exposure of other patients in acute care hospitals to potentially infectious patients.[21] This allowed resource maximization, such as of the staff and equipment that entered the dirty zone, while significantly lowering the risk of cross infection.

Triage

Second, it was a triage site that stratified patients according to their risk levels (Figures 3 and 4). Higher-risk groups could be identified from the outset. For example, phase 2A+ patients, who were older, were at risk of more severe disease.[22-24] The following risk mitigation strategies were implemented for them: (i) thrice-daily vital signs monitoring, as opposed to once daily; (ii) higher nursing ratio; (iii) more frequent clinical reviews; (iv) wearable health care analytic devices that could detect and alert the staff to abnormalities in vital sign trends.

All patients underwent a clinical assessment on admission. Those with worrying features were flagged for frequent reviews with a senior clinician. Board rounds were conducted regularly among various specialists for holistic clinical care. Chest radiographs were obtained where indicated (Figures 3 and 4), reviewed for critical abnormalities, and subsequently reported by a radiologist.

Basic medical care

Third, it provided basic medical care. Resuscitation equipment, including supplemental oxygen, defibrillators, intravenous cannulation, and fluids, was available. At least one junior on shift was trained in Basic Cardiac Life Support and at least one senior in Advanced Cardiac Life Support. Common medications and point-of-care tests, including blood glucose monitoring, electrocardiogram, and ultrasound machines, were available. Laboratory tests could be performed nonurgently. Ad hoc drugs unavailable on-site could be requested and delivered within the same day. A mobile x-ray service was available. Chronic medications were prescribed as needed. Patients with chronic conditions requiring further reviews were scheduled for follow-ups on discharge from the CCF.

Timely reviews and escalation

Fourth, it allowed timely reviews and escalation of patients with signs of clinical deterioration. The medical and nursing staff were available round the clock. Patients could also call the emergency hotline and receive immediate attention. The nursing staff raised patients with abnormal vitals to the doctors for review. Patients in the early stages of illness (phase 2A and 2A+ patients) were reviewed on day 7 of symptoms to watch for potential deterioration. Heightened precaution was taken for patients who desaturated at rest or during the 6-minute walk test, were dyspneic, or remained persistently febrile past day 7 of symptoms. A formal pathway was established to reroute medically unstable patients to an acute care hospital located less than 10 minutes away. Medically stable patients were transferred to hospitals via a round-robin system to prevent single-hospital overcrowding. While awaiting transfer, patients were monitored in the sickbay. On day 14 of illness, stable patients were transferred to a step-down facility.

Patient ownership and responsibility

Fifth, the CCF promoted patient ownership and responsibility while maintaining personal values and space. Measures to promote patient ownership included the following: (i) patient-directed vital signs monitoring, where patients were taught measurement techniques, and did so on their own once competent; (ii) health booklets distributed in their native languages, which educated patients and increased awareness on COVID-19 and the CCF; and (iii) self-performed 6-minute walk tests, with advice on when to seek medical attention. Wireless Internet connection was provided for our patients to remain connected. To cater to our Muslim patients, who formed a majority, and were observing Ramadan, we implemented the following: (i) shifting of meal times; (ii) quiet spaces for prayers; (iii) provision of prayer mats as needed; and (iv) small festivities to celebrate *Hari Raya Puasa*.

Safeguards for mental health and well-being

Finally, the CCF placed a strong emphasis on safeguarding the mental health and well-being of our patients. In total, 99.6% of our patients were noncitizens and comprised migrant workers—a group particularly prone to mental health illness during isolation.[25] There were growing concerns with regard to contracting COVID-19, job security, and implications on their family members. The following mitigating measures were implemented: (i) telehealth counseling in their native languages, by external organizations; (ii) psychological first aid rendered by trained doctors; (iii) a systematic donation scheme, matching patients' needs to donated items; (iv) motivational posters with mental health helplines; (v) movie screenings and art-and-craft stations; and (vi) twice-daily optional mass exercise sessions to encourage activity, safeguarded by pulse oximetry monitoring postexercise, to identify patients who might require medical attention. A psychiatric workflow was constructed to identify patients in psychological distress. Medical officers trained in psychiatry performed risk assessments using standardized tools such as the Columbia-Suicide Severity Rating Scale. Patients who actively displayed the following features were escalated and transferred to formal psychiatric institutions: (i) suicidal ideation; (ii) severe aggression, paranoia, or mania; (iii) relapse of a known mood or psychiatric disorder; and (iv) risks to themselves or others. If patients had concurrent signs of clinical deterioration from COVID-19, they were sent to acute care hospitals, with support from the inpatient psychiatry teams.

Evaluation

Critical factors influencing success

At the time of writing, there were a total of 21 523 patients admitted to the CCF. Of these, only 0.37% required transfers to acute care hospitals. Reasons for transfer included desaturation, clinical signs of pneumonia, and cardiac events. Nationwide, there were 45 140 COVID-19 cases, with 26 fatalities. Of the 4112 active cases, only one required care in an intensive care unit. With the decreasing number of active cases, 4 of the 6 halls have been suspended and

only 2 remain running. Several factors could account for the robust function of the CCF.

Facilities of opportunity

The use of a large convention center allowed quick conversion of the facility to accommodate its functions. Each hall had a similar layout and facilities, allowing familiarity of setup. This minimized the need for reorientation and retraining of staff each time a new hall was opened. Existing partitions between halls facilitated movement and isolation.

Cooperation of multiple regional and national agencies

In the planning phase, a multiagency task force, comprising state health officials, public health personnel, government representatives, health care institutions, and appropriate private partners, was convened. There was a clear delineation of responsibilities and authority. Groups from the private and public sectors worked closely to transfer staff, equipment, and technology to the CCF. Ownership and command of operations, medical care, and logistics were demarcated clearly, and skills of each group matched accordingly. For example, the resort and entertainment chain, whose staff were trained in hospitality and venue management, was in charge of operations command. Minimal training was required, and skills were transferred easily to the CCF. Doctors, nurses, and allied health personnel were enthusiastic and supportive, forming a stable workforce.

Integrated clinical system for monitoring and escalation

Patient-directed monitoring of vital signs allowed timely checks and reduced the nursing burden, allowing attention to be diverted to patients requiring urgent care. Patient dashboards had alerts for abnormal vitals and shock indices. Available paraclinical services aided clinical decision making. Dedicated ambulance services, a centralized hotline, door-to-door paved access between institutions, and geographical proximity to acute care hospitals facilitated rapid escalation.

Clear channels of communication

Open communication between the various stakeholders was encouraged. Feedback from the staff and patients was accounted for and modifications made accordingly, promoting flexibility and adaptability. Cultural sensitivity of the multiethnic patient profile was observed. There was also open communication with the public regarding the opening of the CCF and its services. Translation tools and services ensured smooth communication with patients in their native language.

Limitations

There were several limitations concerning the operations of the CCF. First, there were no negative pressure ventilation settings in the facility, which is ideal for infection control. The setting up of the antechamber with a HEPA filter and the enclosed semi-clean area acted as buffer zones to reduce disease spread. Second, because of the surge in numbers, patients had to double bunk per cubicle, which is not ideal. Cubicles were also not fully enclosed; they were partitioned because of the temporary nature of the CCF. Third, laboratory services had a slower turnaround time of between 4 to 6 hours. However, if laboratory tests were to be required urgently, then transfer to an acute care hospital should be considered. Finally, the patients were in varying stages of illness, and this gave rise to ground concerns of reinfection, although there is presently no data affirming this possibility.[26]

Comparison with other alternative care sites

Community treatment centers (CTCs) were set up in South Korea in response to the COVID-19 pandemic.[27] A study by a center in Gyeongbuk showed similarities with the CCF, for instance, in its function to isolate, cohort, treat positive patients, and use patient self-reporting and digital information systems.[28] However, there were several distinguishing factors; one, our CCF was much larger, holding 8000 to 9000 at a maximum capacity, than the CTC, which had been converted from a dormitory and had a capacity of 300. The large patient load at our CCF prevented the provision of personal shower cubicles. Two, our CCF had an age limit, while the CTC did not—its patients were aged between 7 and 77 years. Our center's age limit was based on studies showing that the older age group was at a higher risk of more severe disease, potentially requiring medical attention that our CCF could not provide. Third, routine monitoring in the CTC comprised temperature taking, but in our CCF, it included pulse oximetry, blood pressure, and heart rate measurements. Thus, patients with asymptomatic tachycardia and desaturation, which could signify early deterioration, could be identified. Finally, our CCF had a semi-clean buffer zone, separating the clean and dirty areas to reduce infection spread.

Cost and applicability

Over a 3-month period, the combined capital, manpower, and operating expenditure of the CCF was projected at around US $8000 per bed. It is cost-competitive and perhaps more cost-effective than other similar alternative care facilities, which had estimated capital expenditures alone of between US $10 000 and $12 000 per bed.[29,30] Singapore's small land area and high accessibility allow for a larger facility, where all eligible patients could be housed in a single center. This significantly lowered the marginal cost per patient. Furthermore, proximity and easy access to acute care hospitals allowed the CCF to focus on non–acute care. On-site services were streamlined to essential ones while ensuring that patients who deteriorated clinically could access critical or more advanced care in less than 10 minutes. In large countries, which have states and cities, and consist of rural and urban landscapes, our CCF may be less applicable, and multiple smaller-scale facilities with at least some capacity for intensive care may be more useful.

Another limitation would be the uncertain nature of the pandemic's duration and possible human resource constraints, which could arise when the staff returned to prepandemic work.[31] For example, our managing agents were from the hotel industry, and a large proportion of the medical staff was recruited from the aesthetics sector. Our CCF was able to overcome this limitation due to concurrent nationwide circuit-breaker measures, including restricting travel and nonessential services, which availed the manpower accordingly.

The CCF would be less applicable in pandemics where the disease has a higher virulence or case fatality ratio, where out-of-hospital treatment may not be suitable.[32,33] Examples include the Middle East respiratory coronavirus (MERS-CoV) or severe acute respiratory syndrome (SARS). It would be less useful where the clinical course of the disease has not been established, or where the disease is poorly understood, making the stratification of patients difficult.

Conclusion

The CCF is a robust concept in response to the COVID-19 pandemic. It is useful in cohort isolation of patients with mild disease. Further studies reviewing transfers of CCF patients to acute care hospitals could help refine admission criteria and escalation workflow. While acute care hospitals remain the mainstay institutions for providing medical treatment, the CCF helps decompress patient load in the former, allowing more efficient resource utilization.

Implications for Policy & Practice

- Peacetime cooperation and communication between private and public groups, especially within the health care sector, are essential for quick recruitment of a stable manpower pool.
- Increased emphasis should be placed on peacetime planning for alternative care sites. This includes a ready task force, delineation of roles, and clear setup and operation plans to facilitate smooth execution during pandemics.
- The CCF is a valuable novel concept and is highly applicable in future pandemics that have high infectivity but low virulence or where a vast majority are asymptomatic or have mild disease.
- Suitability of the CCF depends on the disease, population, and geographic factors. The disease should be well-stratified by severity or risk level, and its course should be understood. Ideally, the majority of the affected patients should have a low risk of severe disease. In addition, area accessibility and interconnectivity are vital considerations.

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