INTRODUCTION

In March 2020, we diagnosed cases of coronavirus disease 2019 (COVID-19) in 53 purpose-built dormitories in the northern and western parts of Singapore, which housed 323,000 foreign workers. Case numbers surged through April 2020 and were not brought fully under control until August 2020. Ultimately, over 54,000 cases were swab-diagnosed and 47% were serology positive for COVID-19, but there were only 25 intensive care unit (ICU) admissions and two deaths among this population. In the context of an uncontrolled transmission during a pandemic, our strategic response was based on three principles — risk stratification, regular and frequent testing, and immediate removal of an infectious source. Thus, we were able to identify workers aged ≥45 years with concomitant comorbidities and move them temporarily and physically from the transmission zone, so that a clean cohort could be maintained.

MOVEMENT OF WORKERS

From May 2020 to July 2020, we repurposed an unused military barrack in northern Singapore, which comprised six blocks, each with a capacity to house 100–400 residents. Individual bunks within each block had 4–18 beds each. Residents from each block were segregated from other blocks. Toilets and shower facilities were available on each floor of the block to facilitate segregation between floors. A fence around the perimeter of the facility with a guardhouse at the entrance allowed for surveillance and contact tracing of anyone who entered and exited the area. In addition, a field medical post was established within walking distance from the blocks onsite to provide medical care for residents.

A total of 1,098 migrant workers were extracted from a total population of 25,000 residents of two high-density parent dormitories. Internal segregation at these parent dormitories was not possible due to the high occupancy rates of over 90%. The parent dormitories consisted of up to ten 13-storey residential blocks. Each storey consisted of multiple bunks, with each bunk shared by up to 12 inhabitants. On each storey were communal toilets and shower facilities. The extracted residents were categorised from the lowest to the highest risk based on a geospatial heat map exhibiting their location, and their proximity to and possible contact with COVID-19-positive individuals. They were chosen based on their higher risk of COVID-19 infection, that is, age ≥45 years and/or presence of medical comorbidities.

When COVID-19 first appeared in migrant worker dormitories in Singapore, it was expected that spread would be exponential due to the high occupancy rates and high-density living quarters. The scale of measures implemented to curtail the spread of a highly transmissible disease in these large scattered clusters required a complex and prolonged response, focused on preventing severe disease and mortality, and isolating suspected cases and COVID-19-positive patients immediately. Parent dormitories were too highly populated, which limited the creation of adequate swing space to isolate COVID-19 patients in situ. Thus, an interim strategy that allowed the displacement of high-risk residents from the infectious source, coupled with close monitoring of these residents, who may still be in the incubation phase of the disease, could help to curtail the spread of infection. In addition, such a strategy could simultaneously free up much needed space in parent dormitories to isolate COVID-19-positive patients in situ, further limiting the rapid spread of infection.

At the repurposed facility, a swing site was created from one of the blocks, where the affected residents were isolated from other blocks and segregated between floors. In addition, an in situ isolation block to house contacts and an interim holding area to await swab results were created. Before entry into the facility, a negative entry swab was required in the preceding 12 h. Thereafter, a testing strategy consisting of serial nasopharyngeal swabs for polymerase chain reaction (PCR) was undertaken to rapidly identify emergent cases. COVID-19-positive individuals were transferred to a tertiary hospital for further management. An onsite medical post was manned by reassigned hospital-based physicians, nurses and volunteers. In addition, a centralised team could perform up to 1,000 swabs daily; the swabs were processed at laboratories optimised for high-volume testing with same-day results. Epidemiological oversight through geospatial heat mapping guided isolation decisions within the facility.

Our residents originated from Bangladesh (40.0%), India (33.8%), China (17.2%), Thailand (5.9%) and Myanmar (2.0%). The diversity of cultural backgrounds (including diverse religions, e.g., Hinduism, Islam) necessitated careful consideration of the religious and dietary requirements of our residents, for example, calls to prayer and breaking fast timings, as the period of our operations coincided with Ramadan. The mean age of our residents was 44 ± 9.6 (range 20–69) years. Approximately 7.4% of patients had comorbidities including diabetes mellitus, hypertension and hyperlipidaemia. Social mixing was discouraged through...
housing of residents with the same ethnic and religious backgrounds, and regular risk communication and community engagement (RCCE).

A proactive approach to RCCE involved serial messaging in seven languages. The messages were broadcasted via a public announcement speaker system and adapted into short videos that were shared through QR code-enabled mobile devices and pamphlets. In addition, face-to-face sessions were conducted to allow bidirectional communication, which helped us to understand the concerns and anxieties of our residents. Hygiene guidelines were reinforced, and early reporting of respiratory symptoms was encouraged. Subscriber identification module cards were provided to the workers, so that they could stream entertainment and maintain contact with their family members. Face masks and hand sanitisers were distributed regularly to improve hygiene standards.

Our strategy of successive PCR swab and serology testing resulted in a total of 101 swab-positive workers, who were identified early and transferred to nearby hospitals. Our efforts yielded a ‘clean cohort’ of 997 workers, who were subsequently transferred back to their parent dormitories after 10 weeks of stay. The clean cohort included 73.2% of residents with both negative serology and PCR results. As entry serology was not sought before entry, some individuals could have had earlier infection [Table 1]. The decision to end the strategy was made when PCR negativity rates reached 100% and the transmission of COVID-19 was under control in the parent dormitories, paving the way for the safe return of residents to their dormitories of origin.

The confinement of residents for prolonged periods may result in stress, depression and anxiety. Inability of residents to venture out on their own and directly interact with their family and peers may also affect their psychological well-being. Frequent monitoring of their psychological state, regular updates to the residents and provision of entertainment are encouraged to ameliorate this.

Our strategy is based on three simple principles — risk stratification, regular and frequent testing, and immediate removal of the infectious source. Interim accommodation for migrant workers may be applicable to institutionalised patients who live in high-density and oftentimes overcrowded institutions in some parts of the world. Residents who are at high risk of contracting the disease can easily be displaced from the source of infection, triaged according to their age and medical comorbidities, then isolated, quarantined and observed for a period of time before their return to society, to ensure freedom from infection and curtail the spread in dormitories and the community. During this period, an onsite medical post can provide timely care for symptomatic patients, while serial PCR testing can be performed to screen for asymptomatic patients who could potentially be infected. Early removal of suspected or confirmed patients can circumvent the spread of disease, with an onsite medical post providing outpatient care, reserving the hospitals for severe cases that require more urgent medical attention.

Table 1. Results of COVID-19 tests performed at the facility at various time intervals.

| Result       | Day 0  | Day 5  | Day 10 | Day 15 | Day 25 |
|--------------|--------|--------|--------|--------|--------|
| PCR negative | 1,098 (100) | 1,081 (98.5) | 1,026 (95.0%) | 997 (97.2%) | 997 (100) |
| PCR positive | 0 (0)   | 11 (1.5) | 55 (5.0) | 29 (2.8) | 0 (0)   |
| Serology negative | – | – | – | – | 730 (73.2) |

PCR: polymerase chain reaction

Figure 1: Swab testing algorithm and disposition plan of residents who underwent nasopharyngeal polymerase chain reaction (PCR) swab testing for COVID-19. ARI: acute respiratory infection, Blk F: separate unoccupied block at the swing site.
CONCLUSION
We describe a real-world experience of closed settings with a high level of transmission and little opportunity to isolate contacts. Innovative approaches can be implemented to minimise the impact of uncontrolled transmission in the context of a pandemic. Each pillar of the response has its challenges including RCCE, logistics of food, sanitation, waste management, hygiene, entertainment, health service delivery, testing, contact tracing, quarantine, and epidemiological data management and response. The strategy we adopted was associated with no severe disease in more than 1,000 high-risk workers and can potentially be adapted to other closed and dormitory style settings such as refugee camps, homeless shelters and prisons.\(^2,7,8\)

Singapore has instituted a multilayered strategy of safe living measures within dormitories to prevent the risks of transmission and detect cases early through wastewater testing and regular routine testing, coupled with swift isolation and containment.\(^9\) Density within dormitories has also decreased. Migrant workers also have access to medical support at regional medical centres, enabled by telemedicine consultations. These measures will ensure a safe living environment for migrant workers and make dormitories more resilient to public health risks, including future pandemics.

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Conflicts of interest
There are no conflicts of interest.

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