An outdoor hotel quarantine facility model in Australia: best practice with optimal outcomes

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Abstract

Objective: To describe the operationalisation of a novel outdoor quarantine facility managed by the Australian Medical Assistance Team, the Howard Springs International Quarantine Facility (HSIQF) at the Centre for National Resilience in the Northern Territory, Australia.

Methods: We collated documentation and data from HSIQF to describe policies and procedures implemented and performed a descriptive analysis of key procedures and outcomes.

Results: From 23 October 2020 to 31 March 2021, 2.2% (129/5,987) of residents were confirmed COVD-19 cases. On average per day, 82 [Interquartile Range (IQR): 29-95] staff completed personal protective equipment (PPE) training, 94 [IQR: 90-104] staff completed antigen testing and 51 [IQR: 32-136] staff completed polymerase chain reaction testing. The operation focused on building a safe environment with infection prevention and control adherence and workforce sustainability. There was no leakage of SARS-CoV-2 to staff or the community and no PPE compromises requiring staff to quarantine for 14 days.

Conclusion: HSIQF demonstrates the operationalisation of an effective, safe and replicable quarantine system.

Implications for public health: Quarantine is a critical public health tool for pandemic control. The HSIQF operations may be useful to inform the establishment and management of quarantine facilities for future and current disease outbreaks.

Key words: COVID-19, quarantine, emergencies, medical assistance, disease outbreaks

International travel has driven global transmission of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). Travel-related control measures, including mandatory quarantine for returned travellers, were implemented early in the pandemic in many countries to reduce the spread of coronavirus disease (COVID-19). Australia implemented mandatory home quarantine as early as March 2020, progressing to supervised hotel quarantine for returned travellers in April 2020. Quarantine is government-run, mostly utilising designated hotels in urban areas.[1]

The transmission of COVID-19 resulting from 'leakage' of the virus from quarantine facilities through infection of staff has occurred in most jurisdictions in Australia. Nationally, quarantine system failures resulting in SARS-CoV-2 infection of a border or health worker, or community member linked to the quarantine and isolation system is estimated to be 4.4 failures per 100,000 travellers passing through quarantine.[2] The largest failure was responsible for 18,418 community cases and 786 deaths.[3] Factors contributing to leakages of SARS-CoV-2 include reliance on shared spaces, lack of adequate ventilation and use of hotels in urban areas with a high population density resulting in potentially accelerated spread of the virus through the community when quarantine system failures occur.[2] Human behavioural factors include suboptimal adherence to infection prevention and control (IPC) guidelines, poor communication, limited staff training, limited availability of personal protective equipment (PPE), lack of a safety climate, and individuals' knowledge, attitudes and beliefs.[4]

As an alternative approach, an outdoor hotel quarantine model, was developed near Darwin, Australia. The facility, named the Howard Springs International Quarantine Facility (HSIQF) at the Centre for National Resilience was implemented by the National Critical Care and Trauma Response Centre (NCCTRC) through the Australian Medical Assistance Team (AUSMAT) upon request by, and with support from, the Australian Government. The operations mandate was to manage quarantine for repatriated Australians through partnership with local contractors for cleaning, catering, security and waste management, alongside local and federal police, the Australian Defence Force and the Australian Department of Foreign Affairs. The model subsequently became known as the 'Howard Springs' model and other jurisdictions have since sought to replicate it.[5,6]

The operationalisation of effective, safe and replicable quarantine systems is an iterative process, one that we could not identify in literature. Here, we aim to describe the operationalisation of the novel outdoor model implemented at HSIQF to ensure the safe passage of returned travellers to Australia.

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Methods

We collated all documentation and data relating to policies and procedures implemented at HSIQF from 23 October 2020 to 31 March 2021. We collected quantitative data regarding returned travellers, flights, resident infection with SARS-CoV-2, staff hand hygiene and PPE training, staff wellness screening, staff testing regimes and use of clinical and telehealth services. An on-site custom-built database (COVID in Communities – 'CIC'; NCCTRC, Australia), included a profile for all staff and residents, to store detailed data, including flight cohorts, wellness screening, testing (with results) and all resident interactions. Training numbers were estimated using QR code attendance check-ins prior to 31 December 2020, then by mandatory attendance at daily SARS-CoV-2 antigen-detecting rapid diagnostic tests (Ag-RDT). Wellness screening numbers were estimated by daily screens performed via an online survey. Total clinical and telehealth service numbers were tracked daily by Clinical Team Leads, supplied to the Mission Lead, and prospectively collated in Microsoft Excel. Data analysis was performed using R Version 4.0.2.[7]

Results

Setting

HSIQF was established at a former natural gas project workers camp that has an area of approximately 148 acres and is located 40 kilometres from Darwin. Darwin has a tropical savanna climate (Köppen Climate Classification subtype 'Aw') with an average daily temperatures 23°C-32.1°C, and 09:00 humidity of 71%.[8] Demountable cabins, 'dongas', were used were used by residents and staff at HSIQF. Each donga contained four rooms and each room had a private adjoining bathroom and a separated balcony. Each donga was separated by 10 metres when front facing and five metres when side-by-side. Dongas were cohorted in blocks, and blocks were enclosed with 2.5-metre wire fence for security (Supplementary Material).

Areas with residents and resident-facing staff were considered 'controlled' (Supplementary Material Block A-F) and a 'non-controlled' area (Supplementary Material kitchen and logistics) was for staff with no direct access to residents, or staff working in the controlled area. There were four areas with separated donning and doffing stations. Three were for entry/exit to the controlled areas, one of which was dedicated to cleaning and waste management contractors. The other was for entry/exit to the non-controlled area. There was further separation of confirmed or suspected cases and close contacts (Supplementary Material Block D). The remainder of the facility were used for a separate domestic quarantine operation, which had no shared facilities, resources or mixing of staff or guests with HSIQF. Police and the Australian Defence Force provided 24/7 foot patrol to monitor staff and residents for public health order compliance. Security contractors monitored closed-circuit television around the facilities perimeter.

Resident journey

Pre-departure

Australian citizens and permanent residents seeking to return to Australia registered through an online Department of Foreign Affairs portal for one-way direct flights with Qantas Airways to Darwin. Passengers required proof of a negative SARS-CoV-2 Polymerase Chain Reaction (PCR) test in the 48 hours prior to departure. For AUSMAT preparation, passengers also completed a voluntary questionnaire to self-identify medical, social and dietary needs, including the use of nebulisers or other respiratory devices ahead of arrival.

Flight arrival

Arrivals were processed through the Royal Australian Air Force Base Darwin terminal, separate to the Darwin International Airport. Biosecurity officers boarded planes prior to disembarkation to identify priority unwell passengers. Those remaining disembarked in seating cohorts of 30, were guided through passport control by Australian Border Force officers, then attended COVID-19 screening by AUSMAT. Symptomatic passengers were escorted to an adjacent room for clinical review and to Royal Darwin Hospital as required. All passengers completed arrival (day zero) nasopharyngeal PCR swabs at the airport, including children with parental consent.

From 23 October 2020 to 31 March 2021, HSIQF received 5,987 passengers (residents) from 34 direct international flights. Thirteen flights arrived from the United Kingdom (37.1%), 13 from India (37.1%), five from Germany (14.3%), and one from each Canada, East Timor, France and the United States (2.9%). On average, flights arrived every five days. Residents were tested on days zero, seven and 12 at a minimum. Day seven testing was introduced 6 December 2020 for early identification of incubating infections missed on arrival. A total 129 residents (2.2%) were confirmed COVID-19 cases (Table 1).

On-site arrival

Following airport processing, passengers were transported by bus for a 30-minute transit to the facility. Residents were briefed by AUSMAT onboard the buses and were escorted to their relevant block upon arrival. QR codes were used to track residents during this process for contact tracing. Resident rooms contained a welcome briefing including all policies and procedures, available support systems and services, an iPad and a voluntary biomonitoring arm band for adults.

Resident cohorting

Residents were cohorted from flight arrival to quarantine clearance. During airport arrival, bus travel and on-site arrival, passengers were grouped into cohorts of 30 according to aircraft seating to minimise close contact if a traveller tested positive on arrival. During the quarantine period, residents were cohorted into relevant blocks and areas within blocks according to risk profiling and protection principles. Non-infected travellers remained in their flights dedicated block as 'general population', whilst confirmed cases, suspected cases and close contacts were moved into further isolation blocks.

Table 1: Confirmed cases of coronavirus disease at Howard Springs International Quarantine Facility at the Centre for National Resilience from 23 October 2020 to 31 March 2021, by resident age and time since resident arrival.

	Residents, N	Confirmed COVID-19 cases, N (%)	Days from resident arrival to positive result, N (%)		
			0–3	6–9	≥11
Total	5,987	129 (2.2)	84 (65.1)	19 (14.7)	26 (20.2)
Age group					
<5 years	811	20 (2.5)	14	4	2
5–17 years	484	12 (2.5)	7	3	2
≥18 years	4,692	97 (2.1)	63	12	22

Vulnerable residents, including those with mobility issues, were allocated to a dedicated block with the easiest staff access. Within each flights general population, groups of dongas were further separated; single males were housed separate to single females and families, families were housed separate from couples, and those with relevant forensic histories identified during routine Australian border entry requirements were further separated.

Telehealth services

The clinical care model prioritised the use of telehealth services to replace face-to-face contact where appropriate, to reduce the risk of SARS-CoV-2 transmission while maintaining quality patient care.[9] Telehealth was performed offsite by non-clinical personnel supervised by clinical personnel to provide language translation, room maintenance, daily health screens and support resident health and wellbeing. When required, telehealth services linked residents to further telemedicine and other essential services, such as general practitioner referral, pharmacy orders, psychological or allied health services. Personalised telehealth screens and telemedicine were provided through an iPad and voluntary biomonitoring. Residents who wore the biomonitoring armband had their vital signs (oxygen saturation, skin temperature, heart rate and respiratory rate) monitored at least twice daily and detection of abnormal parameters automatically triggered an alert to the telehealth team for follow up. The prioritisation of virtual services resulted in telehealth consultations performed more frequently than face-to-face consultations, at a 2:1 ratio for Medical Officers, and 1:9 for nurses/paramedics (Supplementary Material).

Clinical management of COVID-19 cases

A new diagnosis of suspected or confirmed COVID-19 resulted in immediate transfer to the appropriate block. The resident received daily telehealth and face-to-face nursing consultation. Online case conferences were held with Infectious Diseases and Public Health physicians from Royal Darwin Hospital to identify appropriate management plans and streamline admissions, if required. Through collaborative specialist support, all attempts were made to manage residents on-site to minimise the burden on local health services. Only one transfer to Royal Darwin Hospital was for COVID-19 complications (Supplementary Material).

Aircraft wastewater

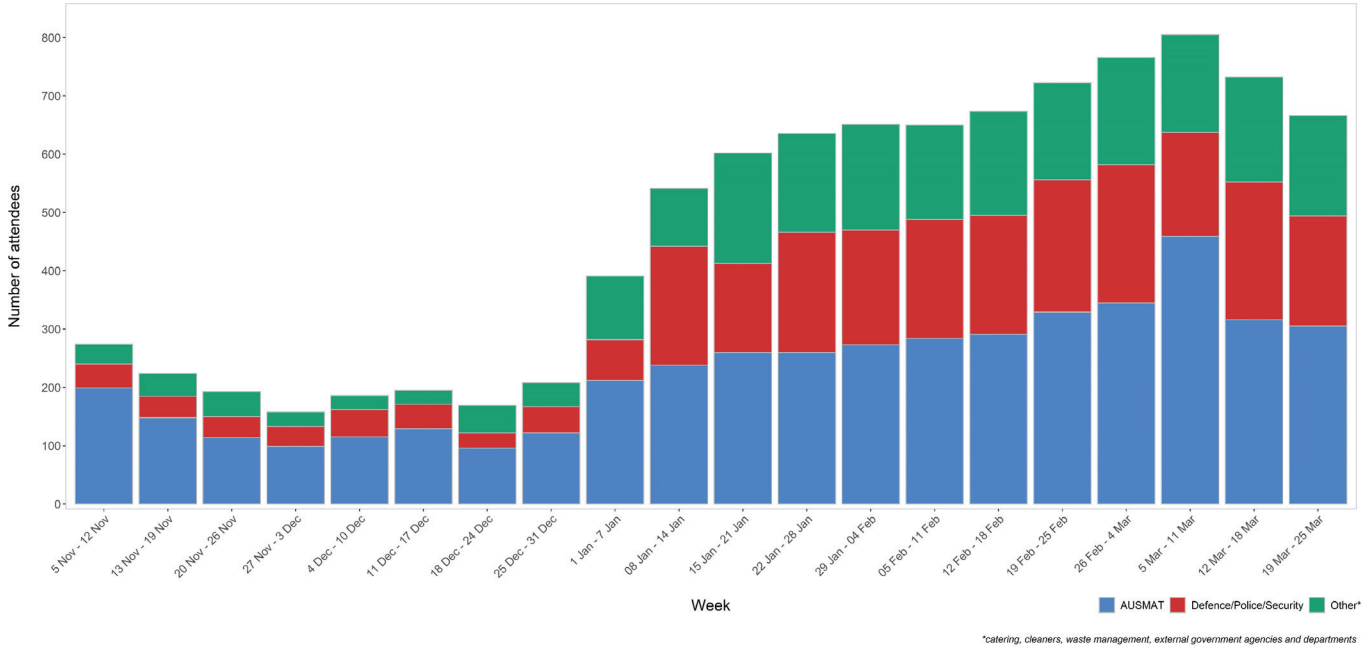
Qantas Airways screened aircraft wastewater samples for SARS-CoV-2 fragments post flight and provided results to AUSMAT which was utilised to confirm the absence of infection and that passenger pre-departure and airport arrival testing had not missed infection. A pooled analysis of a subset of flights from all three reverse-transcription-quantitative-PCR assays demonstrated a positive predictive value of 87.5% and negative predictive value of 76.9% for COVID-19 cases during the post-arrival 14-day quarantine period (83.7% accuracy).[10] Of the COVID-19 cases in the aircraft wastewater analysis, 53.7% were detected on day zero and 89.8% were detected by day seven.[10]

Workforce management

Staff training

All staff were required to undertake comprehensive induction training prior to and upon arrival. This included online and in-person simulation training for all operations and individual PPE training audited for competence. The AUSMAT training model sought to embed IPC practices as 'muscle memory' through repeat practical training, to compensate for cognitive offloading during periods of fatigue.[11,12] Therefore, daily supervised group hand hygiene and PPE training occurred for all staff, irrespective of their assigned activities, to foster camaraderie and ensure all understood IPC principles and safe execution. The training was interactive, requiring donning and doffing of full PPE and application of hand sanitiser. Training attendance increased proportionate to the expansion of the operation, with median of 82 attendees per day [Interquartile Range (IQR): 29-95] (Figure 1).

Figure 1: Daily hand hygiene and Personal Protective Equipment training attendance by staff at Howard Springs International Quarantine Facility at the Centre of National Resilience from 5 November 2020 to 25 March 2021, by week and staff group.



Workforce numbers and cohorting

Staff were allocated into one of five teams each specific to a cohorted flight block with the staff-to-resident ratio varying depending on caseload, staff availability and well-being. On average per day, AUSMAT allocated each block six nurses/paramedics and one general service operator, the facility had 25 general service operators, there were a minimum of two doctors on-site, one doctor on call overnight, and one additional telehealth doctor. There was also a daily management team of Mission Lead, Nursing Lead and Medical Lead.

Staff were restricted to working in their allocated block for the entirety of the cohort's quarantine to minimise potential contamination and mass furloughing. Non-resident-facing staff remained separate from resident-facing staff always. Food was prepared in a controlled area only accessible by catering contractors. Non-contact meal drops to staff and resident balconies occurred daily under AUSMAT supervision and by AUSMAT for confirmed or suspected cases and close contacts.

Limitations on outside work and study

On-site staff were not permitted to work in any other job and were employed on a full-time basis by AUSMAT. Staff were encouraged to complete their required studies online, however, those with-face-to-face requirements were not permitted in controlled areas.

On-site movement tracking

On-site movement tracking was implemented to support contact tracing. Initially, QR check-ins were used per room and by March 2021 a custom-built mobile application with Global Positioning System, Track-Mi, was available to report on proximity and contact with other users of the application. With individual staff consent, the application could also track staff off-site. The application supported the rapid identification of individuals for incident control points, such as close contact to a confirmed COVID-19 case or for evacuation procedures.

Information Technology

A custom built secure central database, COVID in Communities, was developed to coordinate resident care and monitor resident and staff symptom screening and testing. The permission-based system limited access of sensitive information to the relevant clinical team. The system was iteratively adapted to operational needs and was automatically integrated with Track-Mi.

Daily wellness screening

Staff and residents completed daily self-administered wellness screens, capturing temperature, symptoms and heat-related illness. Failed screens were responded to by the clinical team, and symptomatic staff remained in isolation until a negative PCR result was obtained and they were asymptomatic.

Staff testing

Enhanced surveillance for early detection of potential infection was iteratively adapted in accordance with national recommendations and scientific evidence. Initially, staff submitted weekly nasopharyngeal PCR, which progressed to become twice weekly. This was modified to daily Antigen Rapid Diagnostic Tests (Ag-RDT) with weekly nasopharyngeal PCR from 28 December 2020. From 18 February 2021, daily saliva PCR was added to this regime. A positive Ag-RDT initiated a protocol for staff member isolation and tracing until a negative nasopharyngeal PCR was returned. Compliance with daily testing was actively audited in conjunction with the Northern Territory Government Public Health Team. PCR testing was also required before staff arrived from interstate, final site departure and for those planning more than two consecutive days of leave. Contractors not operating in controlled areas were required to complete weekly nasopharyngeal PCR but could also participate in daily Ag-RDT and saliva PCR.

From 1 January to 25 March 2021, there were a total 7,834 Ag-RDT and 6,683 PCR tests performed with a daily median of 94 [IQR: 90-104] Ag-RDT, and 51 [IQR: 32 -136] PCR tests. Total testing per week ranged from 391 and 124 for 1–7 January to 805 and 1,107 for 3–11 March for Ag-RDT and PCR tests, respectively (Figure 2). Testing increased proportionate to the expansion of the operation, and contractors complete testing more frequently than required. For Ag-RDT, there were nine insufficient samples and two false positives. No positive PCR results were recorded in staff.

Vaccination

Staff vaccination with Pfizer-BioNTech (Comirnaty) COVID-19 vaccine commenced 25 February 2021, two days after the vaccine was made available in Australia. HSIQF immediately obtained approval to be a COVID-19 vaccine service provider to vaccinate staff and contractors eligible under the national vaccination program, including set up of cold chain management and record keeping for the Australian Immunisation Register. Vaccination was mandated for all entering controlled areas, prior to the introduction of vaccine mandates in Australia.

Heat-related illness

Strategies to prevent heat-related illness were central to workplace safety given the climate. Daily staff and resident wellness screening monitored heat-related illness, and an on-site wet-bulb thermometer was monitored continuously. Given the risk of dehydration and heat exhaustion whilst wearing full PPE, only emergency procedures were carried out when it was hottest from 12:00 to 15:00. Face-to-face resident consultations were undertaken during relatively cooler periods outside these hours. A random sample of on-site staff who ingested telemetric temperature sensor (e-Celsius; Bodycap; Caen, France) to analyse the impact of heat revealed core body temperatures of 38.5°C during outdoor daytime work. Cold bottled water, air-conditioned workspaces and a slushed ice machine were available to reduce core body temperature, aid recovery from heat exposure and to sustain performance.[13,14]

Quarantine policies and procedures

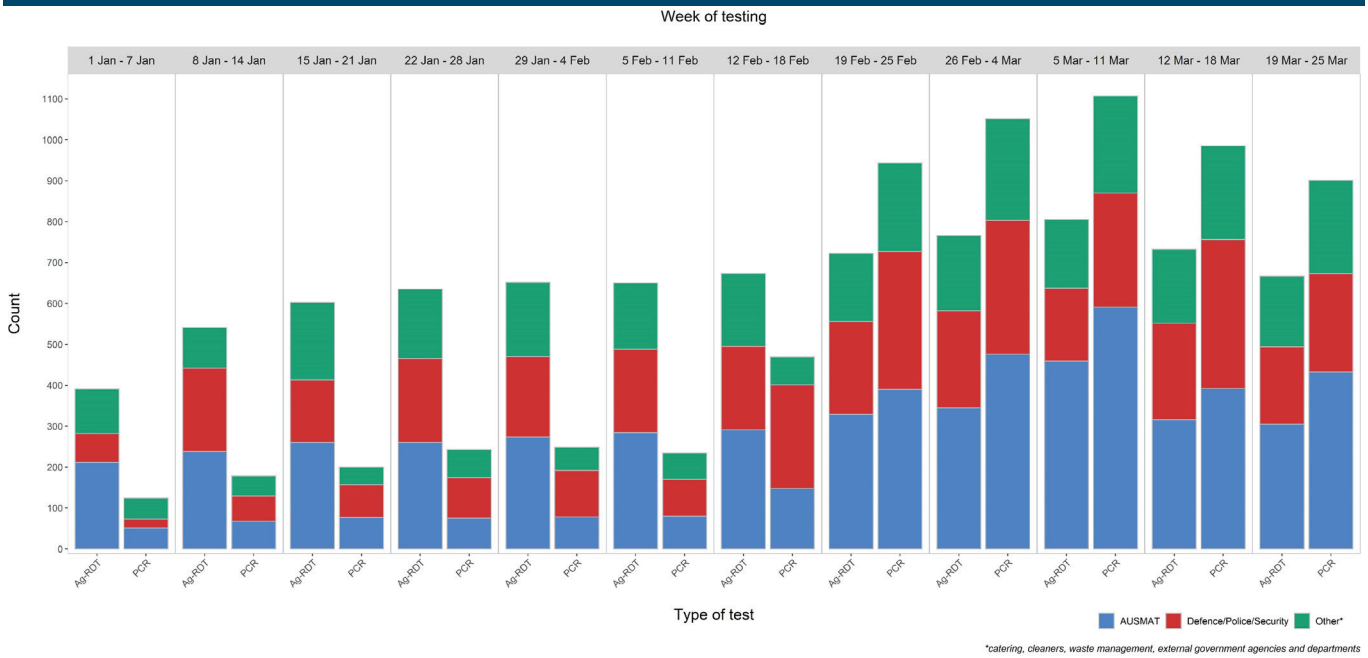
Personal Protective Equipment

PPE protocols were simplified and consistent across the workforce to ensure uniformity and enhance adherence. Low risk activities without face-to-face resident contact required gloves, surgical masks and eyewear. High risk activities required full PPE, including P2 or N95 mask, eyewear, face-shields, two pairs of gloves and gown with taping on the back and cuffs. Taping was used to optimise fit and to prevent PPE compromises during intensive physical activities. Double gloving was necessary due to excess sweat soilage in the climate and potential inability to reapply gloves due to adverse skin reactions after removal of the primary pair. PPE was air-condition-stored in an onsite facility and offsite warehouse, and there were no PPE stockouts.

PPE donning and doffing adherence

A single procedure of donning and doffing was re-enforced and practiced in daily

Figure 2: Number of diagnostic tests performed for severe acute respiratory syndrome coronavirus 2 at Howard Springs International Quarantine Facility at the Centre of National Resilience from 1 January to 25 March 2021, by week, type of test, and staff group.



training. A 'buddy' system was mandated to spot donning and doffing techniques and identify potential breaches. Donning required a photograph to be taken and submitted to the wider team via WhatsApp that was monitored to promote real-time auditing, feedback and adherence.

Doffing was video monitored and by mid-January 2021, dedicated staff were employed to review videos, identify near misses and potential compliance issues and inform management who assessed the level of risk and initiated a practical response. PPE breach reporting was mandatory and as part of the safety culture, reporting of near misses and potential compliance issues experienced or witnessed was promoted.

Overall, there were 45 self-report identified issues by staff that were clinical (31/45, 68%), general service operations (5/45, 11%), cleaners (4/45, 9%), and one (2%) for each catering, clinical/general service operations and defence/police. The most reported issue was not performing hand hygiene for long enough, or not performing hand hygiene between all doffing steps. There were no compromises of PPE protocols requiring staff to quarantine for 14 days.

Physical distancing

Residents and staff were required to maintain >1.5 metres from others and there was a limit of one person per four square metres for indoor spaces unless residents were travelling together in an approved 'travel bubble'. For example, families with young children or couples were placed in adjacent rooms and permitted to share their rooms and balcony. Residents could access personal balconies with masks but were not permitted to leave their balconies unless scheduled to visit the blocks laundry service or rubbish bins. Staff were not permitted to enter a resident's balcony or room unless there was a medical emergency. Staff training and huddles occurred outdoors and there were no common indoor staff areas.

Hand and respiratory hygiene

The mandatory use of consistent hand and respiratory hygiene were reinforced to staff through daily training and procedural posters at donning and doffing stations, and to residents through daily text messages and the on-site television channel translated into multiple languages.

Cleaning, disinfection and waste management

External contractors performed cleaning of all equipment and facilities with disinfectants and equipment approved by the Australian Therapeutic Goods Administration for use against COVID-19. Chlorine-free product was used to disinfect equipment, alcohol-based product for hand sanitising, and portable sinks with soap and water were located at each block entrance for handwashing.

Stringent cleaning protocols were established, with random auditing of protocol adherence conducted by AUSMAT. Residents placed linen in plastic bags on their veranda at the end of their quarantine period, which was removed by AUSMAT logisticians in full PPE and sent off-site for commercial cleaning. All grossly-contaminated items were destroyed. To reduce potential fomite transmission, rooms were furloughed for 48-hours prior to a new resident checking-in to the room.[15] At the end of a shift, staff showered on-site, uniforms were laundered on-site and shoes were disinfected.

Waste in controlled areas were removed by AUSMAT logisticians in full PPE, double bagged, sprayed with disinfectant and handed to waste personnel from a licenced contractor for removal. General waste removal required a surgical mask, eye protection and nitrile gloves under disinfected riggers gloves.

Discussion

In this paper, we describe the novel outdoor model implemented at HSIQF to ensure the safe passage of returned travellers to Australia from countries with endemic COVID-19. The quarantine model resulted in no SARS-CoV-2 transmission to staff or the local community, during a time when COVID-19 vaccination was unavailable or access was limited to priority

groups, and the national strategy focused on disease elimination and suppression. To our knowledge, this is the first example of an outdoor hotel quarantine model, which can inform the implementation of such models in a variety of settings.

HSIQF incorporated best practices developed in other quarantine facility models, including resident cohorting according to risk, day zero resident testing, physical distancing, location tracking, workforce cohorting, telehealth services, symptom monitoring, partnership with local health service and use of police and security monitoring.[16-19] The quarantine model also overcame physical risk factors for transmission in these urban-based models through use of separate cabins and outdoor areas in a tropical climate. SARS-CoV-2 transmission is less likely to occur outdoors and in high-temperature, high-humidity environments, however, we could not identify another outdoor quarantine model in the literature.[20-22]

We also described policies and procedures not documented elsewhere including daily staff testing and training, limitations on outside work and study with full time employment for on-site staff and photographic and video monitoring of donning and doffing. These components addressed cultural factors that may limit IPC adherence, to reassure a safety climate, attract and support staff, and create a sustainable workforce. Daily staff training as a team, addressed potential inadequacies in IPC practice understanding and adherence whilst compensating for cognitive offloading during periods of fatigue.[4,11,12,23] Team-wide involvement in donning feedback and compliance issue identification may further educate and empower staff to communicate and recognise safe IPC execution.[4,23] Enhanced staff testing surveillance was implemented for early detection of SARS-CoV-2 given PCR turnaround time. Although Ag-RDT have lower sensitivity than PCR, when used in a serial manner Ag-RDT effective sensitivity is like PCR.[24] Daily testing was well received, as demonstrated by contractors regular completely daily Ag-RDT and PCR, despite only required to complete weekly PCR.

There are limitations in our description and analysis. Firstly, we presented a finite dataset of a period before the Delta variant surge. However, AUSMAT continued operations at HSIQF until May 2021 and there continued to be zero SARS-CoV-2 transmission to staff or the community despite an increase in SARS-CoV-2 infections from flights arriving from India. Secondly, we have not presented denominator data for staff testing and training activities. Incompleteness of data is due to the operational nature in which it was collected; however, the data presented enhances understanding of the operations. Finally, we did not present costing of HSIQF but recognise that the operationalisation of hotel quarantine must suit local context and available financial resources, including this model compared to other for more traditional models and understand that transferability of all policies and procedures may not be feasible. Despite limitations, there are important public health implications of our research.

Quarantine is a critical public health tool for pandemic control and our model protected the population from COVID-19, leading to its replication across Australia. In addition, we emphasise the importance of iterative procedural refinement according to changing recommendations and evidence for risk mitigation which contributed to the success of HSIQF. Overall, this model can be used to inform the establishment and management infectious disease quarantine facilities, for current and emerging disease outbreaks.

Conclusion

HSIQF demonstrates the success of a novel outdoor hotel quarantine facility, which mitigates SARS-CoV-2 transmission risk and leakage of the virus into the community. The model is an effective, safe and replicable quarantine system that may be used to inform a public health response that protects the population from infectious diseases.

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Ethics

This investigation was conducted under the auspices of public health legislation (Northern Territory Notifiable Disease Act 1997) and ethics committee approval was not required.

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Supporting Information

Additional supporting information may be found in the online version of this article:

Supplementary Figure 1: Sitemap of the Howard Springs International Quarantine Facility at the Centre of National Resilience.

Supplementary Table 1: Telehealth and clinical services provided at Howard Springs International Quarantine Facility at the Centre of National Resilience, 23 October 2020 to 31 March 2021.