Mitigating SARS-CoV-2 in the Deployed Environment

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ABSTRACT

Introduction:

Unlike other communal living environments (universities, boarding schools, and camps) that have been suspended during the COVID-19 pandemic, the deployed military force must continue its mission. Early challenges in the 2020 deployed environment included limited availability of living and quarantine space and limited testing capacity. This is a brief report of stringent quarantine strategies employed to newly arriving cohorts at a NATO and U.S. military base to prevent release of SARS-CoV-2 into a larger base population.

Methods:

With awareness of the worldwide pandemic, beginning in late February 2020, all personnel arriving to the Hamid Karzai International Airport NATO base were quarantined for 14 days to prevent interaction with the wider base population. Testing capacity was limited. Names, locations, and dates of those within quarantine were tracked to improve contact tracing. Between February and April 2020, the first cases of SARS-CoV-2 were diagnosed on a military base in Afghanistan within quarantine.

Results:

Within quarantine, 11 males became PCR positive for SARS-CoV-2 during April 2020. Five of the 11 were PCR tested for symptoms of fever, cough, or loss of taste. A sixth individual, who had been asymptomatic upon leaving the base after completion of quarantine, later developed symptoms and tested positive. Another five asymptomatic individuals were found with antibody testing just before planned release from 14 days of quarantine post-exposure and confirmed with PCR testing. All PCR-positive individuals were diagnosed before being released into the general population of the base because of strict screening, quarantine, and exit criteria.

Conclusion:

Quarantine creates significant strain on resources in a deployed environment. Group quarantine facilities where social distancing is limited allow for the possibility for intra-quarantine transmission of SARS-CoV-2. Ideally, PCR testing is done upon entry into quarantine and upon exit. With the possibility of false-negative PCR or limited PCR testing, we recommend daily symptom screening, pulse oximetry, temperature checks, and small quarantine groups that must "graduate" together—all meeting exit criteria. Any introduction of new individual, even with negative testing, to a group increases risk of SARS-CoV-2 transmission.

Upon exit of quarantine, testing should be performed, regardless of entry testing. If PCR is limited, serology testing should be done, followed by PCR, if positive. Serology testing can be combined with clinical judgment to conserve PCR testing for quarantine release of asymptomatic individuals.

INTRODUCTION

The SARS-CoV-2 virus emerged as a lethal pathogen in November 2019 and has become recognized as a significant pandemic resulting in the COVID-19 infection. By April 2021, there were over 130 million confirmed COVID-19 cases worldwide and over 2.83 million COVID-19-related deaths.[1]

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The SARS-CoV-2 virus reached pandemic levels because of its transmissibility and varied symptomatic clinical presentation. As many as 32% of individuals infected with SARS-CoV-2 can be asymptomatic or minimally symptomatic, which underscores the need to test asymptomatic individuals in congregate living situations.[2] The 1918 Influenza Pandemic spread throughout the military because of personnel movement from crowded staging locations in the USA to the trenches of Europe. As many as 40% of military personnel were sickened, and the virus killed more Americans than the enemy.[3,4] The nature of the military's movement and living conditions increases its susceptibility to contagious pathogens.

Globally, COVID-19 has overwhelmed medical resources, and multiple containment and prevention plans have been developed and reported.[5–7] In the deployed military environment, there is communal living: shared dining facilities, obligatory roommates, communal lavatories, limited workspace, and busy gymnasiums. The largely young, healthy population may demonstrate minimal symptoms.

These conditions increase the stealthy communicability of disease cross-infectivity that occurs within grouped quarantine facilities. Other communal living environments in the USA (universities, boarding schools, and camps) have been intermittently closed during this pandemic to mitigate spread; however, the deployed military force must continue its mission. Therefore, a strict quarantine and testing protocol is necessary to protect the force from a large outbreak that could potentially incapacitate the mission. Despite these inherent challenges, additional mitigation strategies can be added to a strict quarantine process to prevent a large outbreak. The following is a brief report of the stringent quarantine strategies employed at a multi-national NATO and U.S. military base to prevent release of SARS-CoV-2 into a larger base population of 6,000.

DEFINITIONS

Isolation refers to the removal of an individual from the general population for either positive SARS-CoV-2 test results or for symptoms of SARS-CoV-2 infection (person under investigation) but testing is negative or has not yet been performed. The duration of separation at the time was 14 days for COVID-19. Re-testing is often also used as release criteria from isolation.

Quarantine refers to physical separation of an individual after recognized exposure to another person who is potentially infected with SARS-CoV-2. In our population, this included individuals arriving to the base from out of country. In Spring of 2020, the typical quarantine lasted at least 14 days for SARS-CoV-2. The 14-day quarantine selected was based on initial guidance from the CDC and the recent paper by Lauer et al., suggesting most symptomatic patients will present by day 14.[8] Current CDC guidelines have altered many of these recommended time periods. Quarantine provided sufficient time for an exposed person to develop symptoms of COVID-19 or to test positive for the SARS-CoV-2 virus, when available.[9] If neither of those events occurred, then the person's exposure was deemed not sufficient to have caused infection, and further physical separation was not necessary. If the person tested positive or became symptomatic for the SARS-CoV-2 virus, then isolation, as described above, was necessary.

"Clean" quarantine was defined as quarantine in a group with no individuals with SARS-CoV-2 infection. Without ubiquitous pre-quarantine PCR testing, it was impossible to determine the infection status in asymptomatic individuals. While the time in quarantine should be sufficient to allow SARS-CoV-2-infected individuals to develop symptoms, this can only be successful in an environment where an individual has no on-going risk for new infection. Within untested cohorts, the risk of transmission persists within quarantine facilities if social distancing is compromised. The quarantine time period resets if any member of the cohort develops symptoms, tests positive, or a new untested individual is added. With minimal testing capabilities in early 2020 and a low tolerance of risk to release an infected individual back into the large base population, "clean" quarantine was a priority.

BACKGROUND

Medical and surgical care in the NATO deployed environment in Afghanistan is geared toward trauma emergency medical care. Over the last two decades, a small medical footprint was developed that is heavily reliant on early air evacuation out of the theater of operations. It is not resourced for a large-scale infectious disease pandemic. Recognizing the community living of the deployed environment, it was quickly determined that aggressive quarantining and testing strategies were vital to prevent SARS-CoV-2 spread where nearly all personnel were mission essential. Theater policy established the minimum standards of 14 days of quarantine, clean travel, and testing. Each base commander was given the authority to add additional requirements based upon the medical assets locally available and individualized base threats at the outset of the pandemic in Afghanistan. Commanders were also given authority to enforce the process on contractors, government civilians, and civilian contractors. Nonmilitary individuals that desired not to abide by restrictions were allowed evacuation from theater.

The U.S. military and coalition NATO forces in Afghanistan occupy military bases as part of the "train, advise, assist" mission to the Afghan National Security Forces. One of the larger NATO bases shares its name with the nearby Hamid Karzai International Airport (HKIA). Hamid Karzai International Airport base is a multi-national NATO and U.S. military base with a population of 6,000 consisting of active duty military and government contractors from 33 different countries including local nationals from Afghanistan. Since 2012, the HKIA role 2 (R2) medical treatment facility (MTF) has existed with the primary mission of trauma/emergency medical care with transfer to a higher level of care when available. Although HKIA had limited laboratory capability, different serology testing for SARS-CoV-2 IgM/IgG antibodies and a BIOFIRE PCR respiratory panel (including SARS-CoV-2) testing machine were available. In April of 2020, the PCR tests were significantly limited in quantity, mirroring the limited availability throughout the world. As a result, serology testing could be used more liberally, but its utility was yet to be determined.

In February 2020, the R2 MTF clinical staff had increasing concerns that the COVID-19 outbreak may affect the mission capability of the forward operating base (FOB). Quarantine plans were developed to lower the exposure and spread of COVID-19 on the FOB. Starting on March 7, all personnel arriving to FOB HKIA were placed into quarantine for 14 days if they had not completed a 14-day quarantine and "clean" travel previously. During the month of March, all quarantined individuals were housed in an area named "Tent City" composed of four Alaska Shelter tents, each 636 square feet in size (see Figs. 1 and 2). The quarantine process was overseen by a COVID Task Force: a multispecialty group of medical

FIGURE 1. Photo of the living area named "Tent City" demonstrating common area and living tents.

FIGURE 2. Alaska Shelter Tent: internal view of bunk beds demonstrating proximity of living situations.

and operational professionals established to track all individuals arriving on HKIA, track all possible cases of COVID, and provide logistical support to patients in isolation or individuals in quarantine. If any individual tested positive or developed symptoms of SARS-CoV-2 (person under investigation), he or she would be moved to separate isolation quarters.

At the end of March, a group of U.S. contractors arrived to HKIA and were quarantined in the same tent, B-7 (see Figs. 2 and 3). Those individuals arrived after vacationing in numerous international countries from many regions of the world, including North and South America, Europe, Southeast Asia, and the Middle East. Based upon limited available space at HKIA, these grouped quarantine facilities were created containing the fewest number of people. Social distancing and hand hygiene were reiterated by the COVID Task Force lead physician during daily health checks. However, the Tent City area was a dimensionally small area composed of four Alaska Shelter tents: three for sleeping, one dining facility for "to-go" meals, and a shared bathroom/shower area (see Fig. 3).

Late on April 5 and on day 12 of his quarantine, a 53-year-old male smoker (P1) from the above cohort presented to the emergency room with fever and a change in his usual dry cough. A BIOFIRE PCR respiratory panel was performed and was positive for SARS-CoV-2. A close contact trace was completed. All inhabitants of tent B-7 were considered to be close contacts and evaluated for symptoms. Upon interviewing the remaining 11 individuals in the tent, two additional people complained of a new cough. Both were tested with the BIOFIRE PCR respiratory panel and SARS-CoV-2 was detected (P3 and P5). Having completed his 14 days of quarantine, an additional individual (P6) had departed base and traveled to another base in Afghanistan, where he was returned to quarantine immediately. He later developed symptoms on April 9 and a BIOFIRE PCR respiratory panel confirmed he was also SARS-CoV-2 positive.

On April 6, a 59-year-old male contractor (P2) was escorted to the HKIA R2 from tent B-10 for evaluation for a dry cough. He was found to have a positive BIOFIRE PCR respiratory panel with SARS-CoV-2 being detected. His entire tent (B-10) was tracked, interviewed, and re-quarantined if they had been released. After interviewing all residents of B-10, the above bunkmate of P2 was PCR tested because of prolonged close contact without a mask (P4). Despite being asymptomatic, SARS-CoV-2 was detected in this patient. Once the individual in the second tent was identified, the hospital staff was concerned for spread within the entire Tent City (see Fig. 4). As a result, all individuals who had been housed in that area with overlapping dates of those SARS-CoV-2-positive patients were considered to be close contacts and all were restarted on a 14-day quarantine.

At the end of those 14 days, before release, serology testing was performed on the remaining 35 individuals in quarantine based upon a high suspicion for asymptomatic individuals. The desire to serology test was based upon resource limitations of the PCR tests. Five patients (P7-P11) tested positive for IgM and IgG coronavirus antibodies on the Orient Gene COVID-19 IgG/IgM Rapid Test Cassette serology test

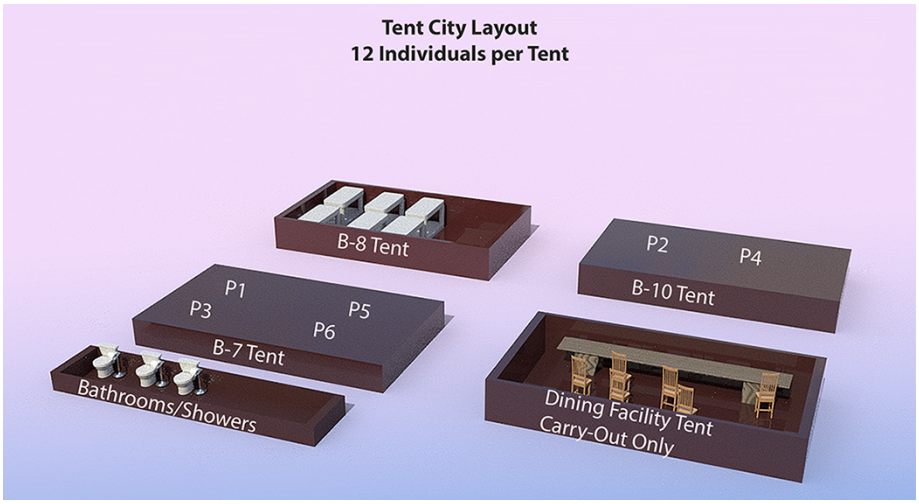

FIGURE 3. Layout graphic of "Tent City" demonstrating the locations of numbered tents, dining facility, and bathrooms.

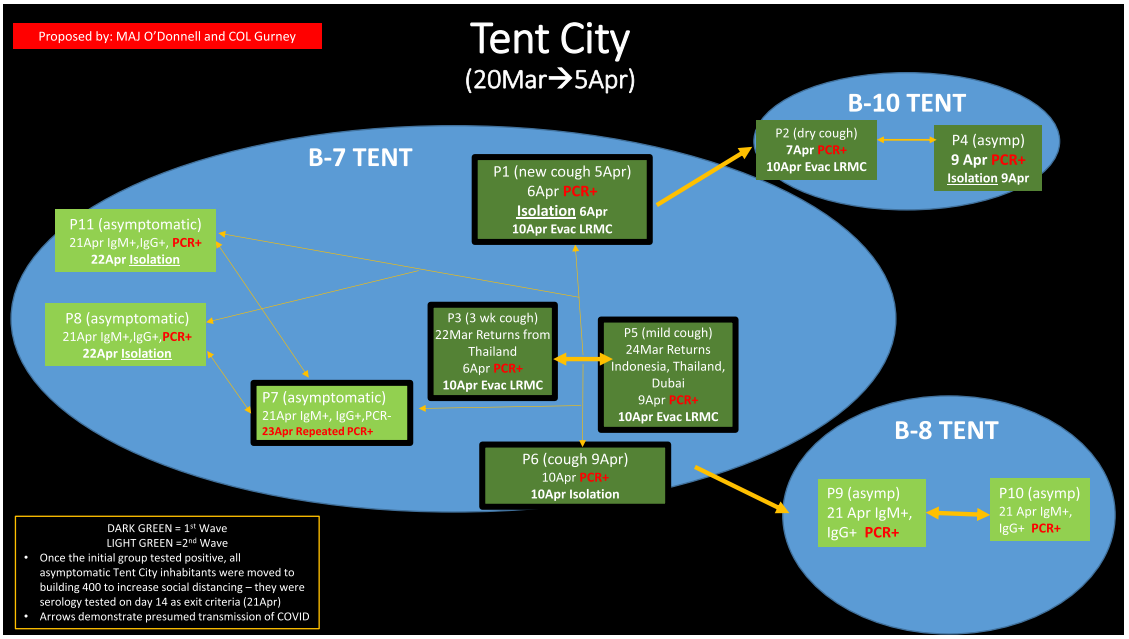

FIGURE 4. Suggested theory of how co-habitants within tent B-7 or B-10 transmitted SARS-CoV-2.

(see Fig. 4). Those five individuals with positive serology tests underwent SARS-CoV-2 PCR testing with the BIOFIRE. All five of these completely asymptomatic patients had SARS-CoV-2 detected on a nasopharyngeal swab within the following 48 hours (P7 initially tested negative on PCR, which was repeated 48 hours later and found to be positive). The remaining individuals with whom they lived in this most recent quarantine were restarted on another 14 days of quarantine for being close contacts of these newly diagnosed patients. At the end of this time period, all remaining quarantined individuals were negative on the Orient Gene COVID-19 IgG/IgM Rapid Test Cassette and developed no symptoms of COVID-19.

RECOMMENDATIONS

Quarantine

Measures must be implemented to keep quarantined individuals in the smallest possible cohorts; individual quarters are the ideal quarantine environment.[9] Individual rooms with bathrooms were not in large supply at this NATO military base near Kabul, Afghanistan. As are most far-forward MTFs with a small footprint, it was originally designed for a damage control resuscitation and trauma surgical capability supporting counterterrorism operations. Ideally, despite communal living, social distancing, Personal Pro-

tective Equipment (PPE), and hand hygiene would prevent SARS-CoV-2 transmission. Unfortunately, 100% of transmission events cannot be prevented, and with asymptomatic individuals and false-negative testing, these events are even more inconspicuous.

Threats Within Quarantine

When creating "clean" quarantining facilities to prepare for worldwide movement during deployments and redeployments, strict adherence to the following principles is imperative. When single-person quarters with individual bathrooms and food delivery are not possible, there will continue to be a possibility for intra-quarantine transmission of SARS-CoV-2. To mitigate disease spread among quarantined individuals, we recommend small cohorts, daily symptom screening, pulse oximetry, and nasopharyngeal PCR testing upon entry into quarantine when feasible. Social distancing must be maintained within quarantine, especially during mask-less activities: when eating, personal/oral hygiene activities, and sleeping. All common surfaces within the quarantined area must be frequently cleaned, with particular focus on doorknobs, tables, and bathroom facilities. Food and laundry delivery must be coordinated by outside personnel. Individuals must have easy access to medical care, either physically or virtually. Lastly, when social distancing cannot be guaranteed within quarantine, a quarantine group must "graduate" together when all are determined uninfected. As evidenced by our experience, the virus can be transmitted on any day during quarantine if precautions are not followed. If one asymptomatic individual from the group is released from quarantine un-tested, he may infect the larger base population.

Quarantine Release

Upon exit of quarantine, testing should be performed, regardless of entry testing. If PCR is not available, serology testing should be done. If PCR is limited, positive serology testing should be followed by PCR. Although PCR-positive patients will be separated before entry into quarantine, there is still a small risk of quarantining a false-negative patient within a quarantined group. Antibody testing of all individuals after 14 days of quarantine improves the ability to capture individuals exposed to SARS-CoV-2, which can lead to increased confidence in PCR test results. For example, if an asymptomatic SARS-CoV-2 person enters a quarantined cohort with initial false-negative testing and transmits it to the group, discovery of this is imperative before release of these individuals into the larger population. Serology testing should demonstrate antibodies if this person was infected upon entry into quarantine 14 days prior and PCR testing should demonstrate who else has become infected.

Consequences

The consequences of releasing any asymptomatic incubatory carriers into the base population were grave. Without ubiquitous PCR resources in theater at the time, there were limitations on the information that could be gathered to know if an asymptomatic individual was infected with the SARS-CoV-2 virus. Using available resources of serology testing, the medical personnel at HKIA sought to gain additional information on individuals being released from quarantine to prevent community spread. Our supposition was that if there were an individual with SARS-CoV-2 infection (re-quarantined for a total of 28-44 days), there would be sufficient immune response to demonstrate a positive antibody response on the last day of quarantine. In addition to being afebrile and asymptomatic, negative serology testing became a standardized exit criterion for quarantine release prior abundant PCR availability. While the validity of the serology tests remains in question, what is clear is the need for quarantine groups to "graduate" together.

CONCLUSIONS

Due to limited physical space and the lack of housing facilities with individual bathrooms, quarantined individuals were placed into cohorts based upon day of arrival into the country. Once a positive case was identified from a quarantine cohort, the close contacts of the individual were restarted on 14 days of quarantine and groups were not mixed with any new individuals being put into quarantine. It is clear that if social distancing is not maintained within quarantined groups, SARS-CoV-2 infection can be transmitted among the cohort. The risk of needing to restart 14 days of quarantine becomes increased when groups are quarantined together in communal living areas. In the above scenario, some individuals remained in quarantine for 44 days from March 22 until May 4 before they could be released. Lastly, the presence of truly asymptomatic incubatory carriers was a silent threat undetectable without pre-quarantine testing available. The SARS-CoV-2 infection was transmitted within the quarantine population that was asymptomatic upon entry on day 1 of quarantine. The positive testing of P4 and P7-11 further confirmed the presence of asymptomatic individuals.

A large-scale outbreak on deployed military bases poses a risk to force and to the mission. The deployed trauma system was developed to decrease preventable deaths in the deployed environment to zero. The response to the emerging threat of the COVID-19 medical pandemic used that same goal. In order to avoid a large-scale outbreak that could rapidly overwhelm the medical and evacuation resources, strict quarantine procedures were adopted and implemented. Even with daily involvement of a physician reminding people to maintain social distancing, intra-quarantine SARS-CoV-2 transmission occurred. Asymptomatic COVID-19 incubatory carriers were present at the beginning of quarantine but undetected because of the lack of pre-quarantine testing resources. Using serology tests as an exit criterion for quarantine allowed for a more limited use of the PCR tests to capture asymptomatic carriers. Ideally, PCR tests would be used as exit criteria. Extending quarantine for those determined to be "close contacts," although resource-intense logistically, pro-

vided the best defense strategy to prevent release of asymptomatic carriers into the wider base population. Deployed environments often have less ability to test, manage critically ill patients, and socially distance. Widespread illness can result in reduced mission capability. Pristine management of quarantine before movement into theater is integral to successful protection of the force.

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CONFLICT OF INTEREST STATEMENT

None declared.

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