Prevention of Travel-related Reintroduction of COVID-19 Infection in the State of Hawaii

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JUNE 9, 2020

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This plan proposes to limit travel-related reintroduction of COVID-19 into Hawaii, averting further local transmission of the virus from travelers to the community. The plan is epidemiologically sound and conceptually straightforward. Air passengers cleared to travel by screening for specific markers will pose a much smaller risk of transmission to Hawaii residents. Individuals clearing both (1) temperature and symptom screening in their departure city and (2) a COVID-19 test in their departure city will not be required to quarantine for 14 days on arrival in Hawaii. Specific timelines for testing relative to embarkation are provided.

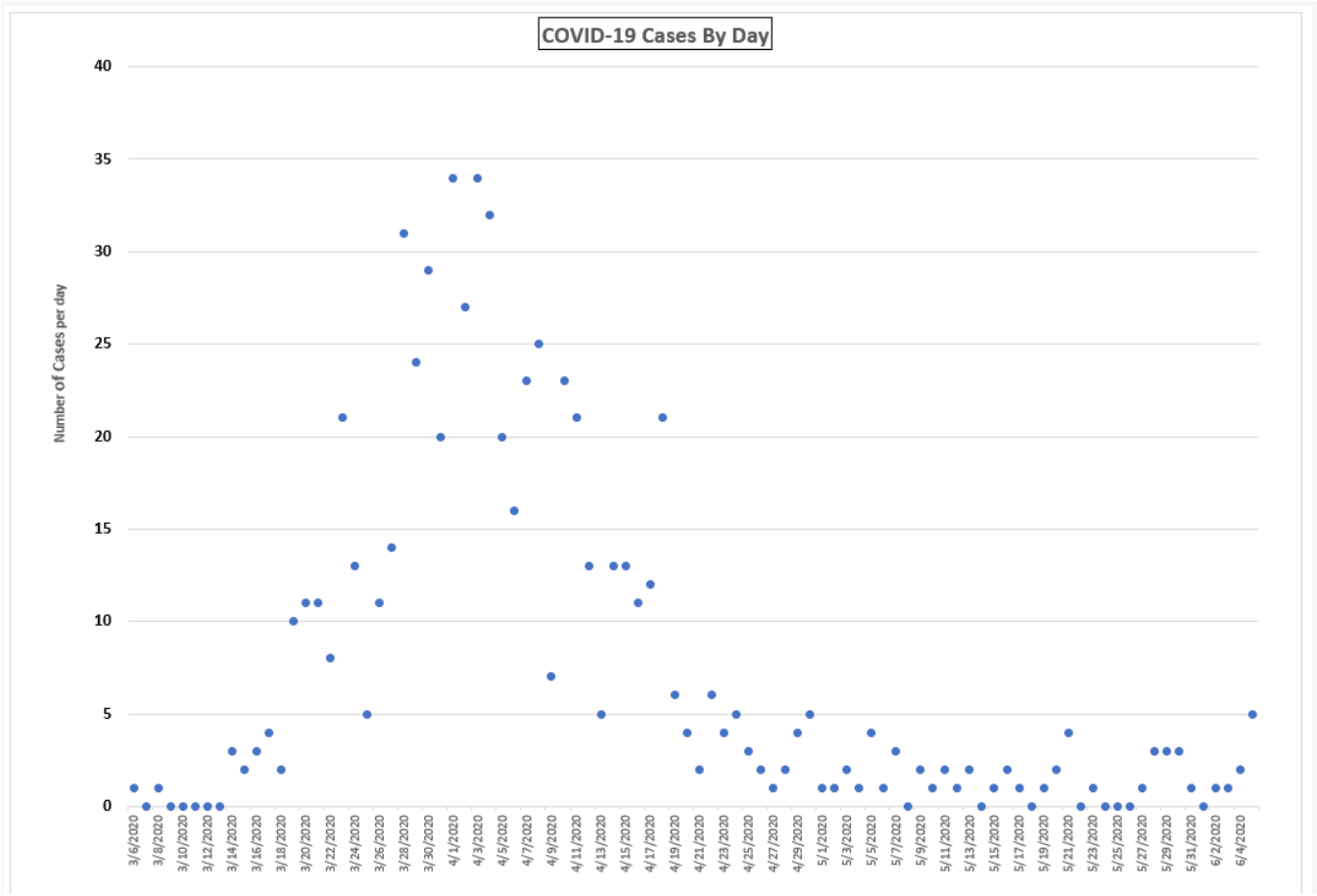
Clearance documentation is to be completed electronically, using a mobile phone app linked to a cloud database for receiving and distributing passenger test results. Results will be maintained confidentially and only distributed to the passenger, their ticketed airline, home state and Hawaii public health authorities and, if requested, their private physician. Any person arriving in Hawaii without the required clearance documentation will be quarantined for 14 days. Hawaii state and county governments will be required to strengthen quarantine enforcement beyond current levels. Otherwise, large numbers of passengers will avoid taking a COVID-19 test prior to departure and then attempt to break quarantine in Hawaii (Halliday 2020). In sum, travelers are required to either test there or be quarantined here.

Is our pre-boarding testing plan likely to work and protect the Hawaii community from a second wave of COVID-19 infections once tourism restarts? We have three clear conclusions:

- Screening air passengers for high temperatures and COVID-19 symptoms in their departure city removes about one third of infectious passengers from flights to Hawaii.
- Adding a second screen—testing air passengers for COVID-19 infection with an RT-PCR test in their departure city—removes 80-90 percent of infectious passengers from flights to Hawaii.
- If tourism resumes with 6,000 visitors arriving daily who are only screened for temperature and symptoms, we estimate this will lead to 750 additional active infections present in our community each month among visitors and residents. Adding the second RT-PCR screen reduces additional active infections each month to roughly 150 people.

HAWAII IS NEAR COVID-19 ELIMINATION, HOW DO WE SUSTAIN THE SUCCESS?

As shown below, the COVID-19 epidemic increased dramatically in late March, followed by an equally dramatic decrease in mid-April. Ongoing local transmission has remained low since April 24, 2020. By continuing current prevention measures, it would be feasible to effectively eliminate COVID-19 transmission within Hawaii. As travel to Hawaii resumes, ongoing reintroduction of the virus from returning residents and visitors will make this near elimination very difficult to sustain.



Active COVID-19 infection is much more widespread in many of the countries and U.S. states sending visitors to Hawaii than it is locally. As a result, incoming visitors and Hawaii residents returning from these locations are likely to have higher levels of infectious COVID-19. As of 17 May 2020 about 0.42 percent of the U.S. population was estimated to have an active COVID-19 infection (Imperial College 2020). This is six times higher than the upper bound estimate for Hawaii, 0.07 percent (Imperial College 2020). Specific states sending large numbers of visitors to Hawaii – California (0.23 percent), Arizona (0.55 percent), Washington state (0.12 percent), Illinois (1.39 percent), New York (0.43 percent), Texas (0.31 percent) and Colorado (0.82 percent)—all have higher percentages of people infectious with COVID-19. Incoming visitors will obviously increase the risk of generating community transmission within Hawaii.

THE KEY TO SUSTAINED SUCCESS: PREVENT ENTRY OF ACTIVE COVID-19 INFECTIONS

Given the epidemiological difference between the Hawaii population and the origin populations of our visitors and returning residents, the key to keeping infections in Hawaii low is to stop incoming travelers from repeatedly reintroducing COVID-19 to our Islands and reseeding community spread. One effective way to do this is to test and screen those flying to the Islands for active COVID-19 infection before they can interact with the people of Hawaii. Before describing the details of the approach, it is useful to consider some general principles.

Where to test: The goal of pre-flight testing is to keep people actively infected with COVID-19 from boarding a plane to Hawaii. To maximize its impact on public health, testing for COVID-19 among travelers must be completed at the point of **departure** rather than upon **arrival** in Hawaii. Testing at the point of departure confers five important benefits:

- Individuals obtaining test results 24 hours before departure will know their results prior to leaving for the airport. Those who test positive will remain at home. This will reduce the risk of transmission at crowded airport check-in, security, and boarding facilities. Airlines and hotels could refund fares and deposits/prepayments (without penalties) to passengers with positive test results. Hawaiian Airlines has implemented this policy for passengers with a high temperature or COVID-19 symptoms pre-departure (O'Connor 2020).
- Pre-departure testing will substantially reduce the chance that a passenger with active infection is on a flight to Hawaii. This protects the ground crew, other passengers, pilots and flight attendants who might otherwise be exposed to COVID-19 on the flight. Given the current lax enforcement of passenger masking policies by most airlines serving Hawaii, this is an important benefit (Mzezewa 2020).
- Pre-departure testing protects employees and other travelers at Hawaii's arrival terminals by reducing the number of potentially infected people on incoming flights.
- If passengers were to be tested on arrival to Hawaii and found to be positive, this would require isolation in Hawaii, imposing substantial financial burdens on the arriving traveler for housing, food, and medical care. It would also add to the burden on Hawaii's limited health care facilities.
- Those testing positive prior to departure can more easily rely on their own health insurance coverage, use their local medical care facilities, and quarantine at home at lower cost than in Hawaii. Detecting these infections, isolating positive individuals at home, and initiating contact tracing at their point of origin will also benefit prevention efforts in the passenger's home community.

When to test: From an epidemiological perspective, testing and obtaining results closer to departure time reduces the chances that those testing negative will be exposed and infected between when they take the test and when they depart. While 24 hours from specimen collection to boarding is feasible, it may be impractical given the current state of testing infrastructure in departure sites and the timing of early-morning and late-night flights. Accordingly, for now a 72-hour pre-departure window is proposed. This should be sufficient to allow travelers to obtain a test through their own physician, private testing companies, or public testing sites. In the future, the goal should be to minimize the time between testing and travel. As testing technologies are improving rapidly, over time this pre-departure testing window can be shortened as faster and better tests become available.

A PRE-BOARDING TESTING AND SCREENING STRATEGY TO PREVENT COVID-19 REINTRODUCTION

The intended traveler will be asked to undergo a series of screens, tests and declarations to reduce the likelihood that a passenger with COVID-19 is allowed to board a plane to Hawaii.

First test: fever, symptoms, and declaration. The most frequent symptoms of COVID-19 infection are fever, cough, and fatigue (CDC 2020). Thus, the first test is for fever using a medical infrared thermometer. Any temperature above 100.4 degrees Fahrenheit (38 degrees Celsius) indicates a fever. During the screening procedure, the tester will note any symptoms and will ask the person "have you been ill lately?" and "do you feel ill now?" prior to taking their temperature. A declaration will be provided to the tester for the passenger to read, sign and return affirming the answers to the questions on illness and stating that they are unaware of any exposure to a known or potential COVID-19 patient and have not been notified of any high-risk community exposures, e.g., being told they are a close contact by local health authorities. The person testing the passenger will enter to the electronic system: 1) the results of the fever test, 2) any observed

COVID-related symptoms or positive responses on the questions regarding illness, and 3) an affirmation that the declaration has been signed.

The ability of fever and symptom screening to detect COVID-19 infections depends on many factors, e.g., the proportion of those with active COVID-19 who are asymptomatic or pre-symptomatic, the proportion of those with COVID-19 who develop fever as a symptom, or how far along the individual is in the course of their illness. The sensitivity of a test is the percent of those with infection detected by the test. The sensitivity of fever testing for COVID-19 in airports has been modeled to be anywhere from a few percent to just above fifty percent, but it invariably misses many infections (Gostic 2020, Quilty 2020). In a real-world example, researchers analyzing the return of residents to Taiwan in Winter 2020 found that 32.7% of those with active COVID-19 infection were picked up through body temperature and symptom screens on arrival at the airport (Liu et al. 2020). Thus, it seems likely that this first test will only pick up about one-third of all actively infected individuals.

Table 1: Testing Results With Temperature/Symptoms Test

Number of Passengers 6,000

Test Specificity 0.99

Prevalence (%)	**1.0**		**0.75**		**0.42**		**0.2**		**0.1**		**0.05**	
Sensitivity	**False+**	**False-**	**False+**	**False-**	**False+**	**False-**	**False+**	**False-**	**False+**	**False-**	**False+**	**False-**
0.5	59.4	30.0	59.6	22.5	59.7	12.6	59.9	6.0	59.9	3.0	60.0	1.5
0.45	59.4	33.0	59.6	24.8	59.7	13.9	59.9	6.6	59.9	3.3	60.0	1.7
0.4	59.4	36.0	59.6	27.0	59.7	15.1	59.9	7.2	59.9	3.6	60.0	1.8
0.33	59.4	40.2	59.6	30.2	59.7	16.9	59.9	8.0	59.9	4.0	60.0	2.0
0.3	59.4	42.0	59.6	31.5	59.7	17.6	59.9	8.4	59.9	4.2	60.0	2.1
0.25	59.4	45.0	59.6	33.8	59.7	18.9	59.9	9.0	59.9	4.5	60.0	2.3
True Positive	60		45		25.2		12		6		3	
True Negative	5,940		5,955		5,975		5,988		5,994		5,997	

Table 2: Testing Results with Sequential Temperature/Symptoms Test and RT-PCR Test

Prevalence	**1.0**		**0.75**		**0.42**		**0.2**		**0.1**		**0.05**	
Adj Prev.	**0.67**		**0.5025**		**0.2814**		**0.134**		**0.067**		**0.0335**	
Sensitivity	**False+**	**False-**	**False+**	**False-**	**False+**	**False-**	**False+**	**False-**	**False+**	**False-**	**False+**	**False-**
0.99	58.8	0.3	59.0	0.2	59.2	0.1	59.3	0.1	59.3	0.0	59.4	0.0
0.95	58.8	1.7	59.0	1.2	59.2	0.7	59.3	0.3	59.3	0.2	59.4	0.1
0.9	58.8	3.6	59.0	2.7	59.2	1.5	59.3	0.7	59.3	0.4	59.4	0.2
0.8	58.8	8.0	59.0	6.0	59.2	3.4	59.3	1.6	59.3	0.8	59.4	0.4
0.77	58.8	9.7	59.0	7.2	59.2	4.1	59.3	1.9	59.3	1.0	59.4	0.5
0.7	58.8	13.5	59.0	10.1	59.2	5.7	59.3	2.7	59.3	1.4	59.4	0.7

Note: Adjusted Prevalence adjusts number of true positives in sample after temperature/symptoms test that is 33 percent sensitive.

Table 1 provides the results of 36 different temperature/symptom testing scenarios as a function of the sensitivity of the test, the level of active COVID-19 infection in the tested population and the specificity of the test (the percentage of uninfected passengers who are correctly identified by the test). For discussion purposes, we focus on one example that reasonably reflects the current situation and expectations for the impact of this first testing procedure.

ILLUSTRATIVE EXAMPLE OF THE LIMITED IMPACT OF FEVER/SYMPTOM TESTING AS TOURISM RECOVERS

Given general concerns about COVID-19, the economic impact of the epidemic on the US, and the fear many have of flying under current conditions, we examine a scenario in which tourism initially recovers to only one-fifth of its previous levels. Thus, instead of 30,000 passenger arrivals a day, assume that 6,000 arrivals occur each day. Further assume that a little less than half a percent, 0.42 percent, of these passengers have active COVID infections. This is the estimated level of infectious individuals in the USA on 17 May 2020 (Imperial College 2020). Without any screening there would be roughly 25 people with active COVID-19 infections arriving each day, a combination of tourists, returning residents, and airline crew. With no screening this would mean approximately 750 infected passengers arriving each month.

If we assume a first test is done with fever and symptom screening that detects one-third of the infected, and these individuals do not travel, then the daily influx is reduced to about 17 passengers unknowingly infected with COVID-19 or about 500 a month. At present, estimates from different models for the reproduction rate (R_t), that is the number of people infected by each infected individual vary from 0.5 to 0.9 for Hawaii (Imperial College 2020, COVID Act Now). If the 14-day quarantine for incoming travelers is lifted entirely, and we make the **conservative assumption** that each incoming infection only generates 0.5 additional infections because incoming travelers practice good social distancing and wear masks during their entire stay, this would add an additional 250 infections a month. This gives us a total of 750 COVID-19 infections in Hawaii per month with a resumption of tourism and only temperature/symptom screening in place. Such a burden will quickly overwhelm the capacity of our health care system.

These calculations have been made under the assumption of 6,000 arriving passengers a day, only 20 percent of Hawaii's 30,000 arriving passengers per day in 2019. If the number of incoming passengers doubles to 12,000, then the number of infections among tourists and returning residents and the number of infections generated in the community could also be expected to double. For those who doubt the incoming burden of COVID-19 can be this high, consider that there were 178 travel-related cases identified in Hawaii in the last half of March, when passenger flows were already rapidly falling, the quarantine requirements were being put into place, and the caseloads in the continental United States were still rising.

A second test: an RT-PCR test for active COVID-19 infection. The above analysis illustrates that a fever/symptom screening check alone is inadequate to staunch the influx of infections into our community if tourism recovers even partially and the quarantine requirement is removed.

To address this, a second test for the presence of active COVID-19 viral infection is essential. Tests for viral infection are typically done using either the RT-PCR test or the antigen test. Our proposal is to use the RT-PCR test because this test is currently more sensitive (i.e., better at detecting infections) and specific (i.e., less likely to falsely identify someone as infected) than the antigen tests. With an RT-PCR test, a nasopharyngeal specimen from each nostril is amplified by RT-PCR (taking about 45 minutes) allowing the direct detection of virus nucleic acid. This is currently the standard test used to detect current active infections for diagnostic purposes.

One of the characteristics making COVID-19 difficult to control is that a significant proportion of those with COVID-19 infection are either asymptomatic throughout the course of their infection or in a pre-symptomatic phase that averages about five days. ***The fever/symptom test would miss these people, but this second RT-PCR test will detect most of these asymptomatic infections.*** Without it, almost all of them would be permitted to board their flight to Hawaii. Anyone testing positive on this test should be denied boarding, immediately seek medical advice, and self-isolate to protect their home community.

Table 2 provides the results of 36 different testing scenarios where **both** the fever/symptom test and the RT-PCR test are applied sequentially. It assumes the fever/symptom check detects one-third of those with

active infection and then applies the RT-PCR test to the remaining potential passengers. (Passengers with fevers will still have an RT-PCR screening despite being unable to travel.) As with Table 1, it depends on the sensitivity and specificity of the RT-PCR test and the overall prevalence in the population being tested. As before, the following discussion focuses on one example that reasonably represents the current situation and the expectation for the impact of the first test procedure.

ILLUSTRATIVE EXAMPLE OF COMBINED IMPACT OF BOTH TESTS IN REDUCING COVID-19 RE-INTRODUCTIONS

When correctly administered, the RT-PCR test has a sensitivity of 75 to 85 percent, identifying from 75 to 85 percent of active infections. Extending the previous example, assume that the infectious percentage of passengers is the 0.42 percent average for the US. With 6,000 passengers per day, about 25 of them are actively infected with COVID-19 and the fever/symptom test will remove one-third of them, leaving about 17 per day. If the RT-PCR test is then 80 percent sensitive, it will detect 13.6 of them, leaving about 3.4 per day to board the plane. This works out to roughly 100 per month arriving in Hawaii. If they each generate another 0.5 infections, we end up with only about 150 new active infections each month present in Hawaii. Consider this summary of the results:

- **If no testing is done**, then 750 incoming passengers with COVID-19 infection would result in 375 additional infections among visitors and residents, which equates to **1125 new active infections per month**.
- **If only temperature and symptom screening is used**, then 500 incoming passengers with COVID-19 infection would result in 250 additional infections among visitors and residents, which equates to **750 new active infections per month**.
- **If both tests are used**, 100 incoming COVID-infected passengers would result in 50 new infections among visitors and residents, which equates to roughly **150 new active infections per month**.

What if the population of air passengers is substantially less likely to be infected with COVID-19 than the overall population in any given state? In this case, the numbers of new infections introduced by air passengers would fall proportionately, e.g., a 10 percent reduction in the percent of infected travelers would reduce the active infections described by 10 percent.

FALSE POSITIVE TEST RESULTS

If the test is 99 percent specific, then one percent, roughly 60 of the 6,000 people taking the test daily, will have positive test results when they are actually free of infection. To reduce this number of false positives, we recommend immediate RT-PCR rescreening which will substantially reduce the number of false positives. But for those uninfected who continue to test positive, there will be a requirement to quarantine for 14 days at home, with the concomitant lost income, mental stress, and other costs of a 14-day isolation. However, this is counterbalanced by the public health benefits to their home communities of identifying 650 people who are truly infected with COVID-19 and moving them into a 14-day isolation. With the average reproduction rate ($R_t = 1$) in the United States, this will avert an additional 650 infections in their communities each month or 7,800 COVID-19 infections per year.

In sum, keeping infected people off planes flying to Hawaii is not free. The two screening tests use scarce resources and some healthy people are unnecessarily quarantined. However, these are costs that some visitors are almost certainly willing to pay for the chance to visit a very healthy Hawaii.

LOCATIONS WITH LOW COVID-19 PREVALENCE

Given the COVID-19 infectivity levels in the United States in mid-May 2020, testing of air passengers will clearly be productive in reducing the number of active COVID-19 infections coming into the State. **However, when the percentage of active COVID-19 infection falls below 0.1 percent, the testing procedure will avert only a small handful of infections.** Consider New Zealand, a nation of 4.8 million people which has not reported a COVID-19 case since May 15, or South Korea, a nation of 51.6 million people reporting an average of 33 cases a day since May 15. In both countries, the percent of infectious people is less than 1/10th of one percent and less than or equal to the percent of infectious people in the overall Hawaii population. The last panel of Table 2 shows that the RT-PCR testing prevents relatively few arrivals of air passengers infected with COVID-19 at these low prevalence levels. Resources could then be more efficiently used to control sporadic transmission of the virus among residents and tourists here in Hawaii. Proposals that allow residents of New Zealand, South Korea, and Australia—all places with levels of prevalence equal to or less than the levels of prevalence in Hawaii—to enter Hawaii with just temperature-symptoms screening look promising as long as low levels of prevalence persist in these places. Entry from these countries should, however, be restricted to residents of the country to prevent residents of countries with higher prevalence from transiting through lower prevalence countries to enter Hawaii. In addition, screening questionnaires should include information on all recent travel outside of the resident's country of origin. Finally, decisions on countries included in travel corridors should be dependent on current data on infection rates in each country, and should be updated regularly.

Could residents of Japan enter Hawaii without RT-PCR testing? Japan, a nation of 130 million people, has reported between 14 and 89 cases daily since May 13, but also has done extremely little testing, just 314,483 tests as of 7 June 2020. Before Japanese residents are admitted to Hawaii without RT-PCR testing, Hawaii authorities should obtain better estimates (perhaps from recent Japanese sentinel surveillance testing) of the percent of Japan's population currently infectious with COVID-19.

TRAVEL REQUIREMENTS AND COVID-19 TRAVEL DOCUMENTS

Passengers will be notified during the process of purchasing their air ticket to Hawaii of required testing or quarantine protocols. They will be asked to acknowledge their acceptance of these protocols and informed to register on the safetravels.hawaii.gov website.

Travelers will be expected to follow all standard COVID-19 prevention precautions in place. All travelers must be masked while waiting inside the departure airport terminal, on boarding, in flight, and upon arrival. Boarding and in-flight policies are under airline control, which have all adopted mask wearing policies for passengers and staff but unfortunately chosen not to enforce them. Arrival policies are under the control of Hawaii authorities and masks are required in Hawaii airports.

The travel documents necessary should be completed electronically prior to boarding and, if at all possible, during the on-line check-in process at home. All test results (temperature, symptoms check, questionnaire and declaration and RT-PCR) are sent by the person administering the test to a secured and confidential cloud database, with results only accessible to the passenger, the passenger's airline and home state and Hawaii health authorities.

TEST, CONTACT TRACING, AND FOLLOW-UP – THE BACKUP

Even if the proposed testing protocols are applied uniformly, some infected asymptomatic people will still enter Hawaii and potentially spread infection. Temperature and symptom screening combined with RT-PCR testing will detect most, but not all currently active COVID-19 infections. However, if tourists,

returning residents and airline crew maintain social distancing practices and wear masks in public places, transmission of the virus could be minimal. Accordingly, educational information and videos should be provided on the plane informing visitors of Hawaii's policies for COVID-19 prevention and asking for their aloha in complying with them. Hawaii authorities must also have the capacity to rapidly identify infections and respond immediately through testing and surveillance. A sound surveillance system that monitors high-risk settings in the tourism industry is important for anticipating and stemming transmission. Relevant populations for surveillance include any workers with frequent contact with visitors, such as restaurant servers, front desk staff, housekeepers, and any other high-contact occupations. Any of these workers developing potentially COVID-19 related symptoms should be offered testing, followed by aggressive contact tracing and workplace testing.

Surveillance must be accompanied by rapid testing of possible cases and identification of close contacts. Contact tracing by Hawaii health authorities enables close contacts to be quickly identified, tested, and isolated. Sufficient capacity must be in place to monitor their symptoms and compliance with isolation orders. State authorities also must have capacity to analyze outbreak data and to communicate information about the outbreak to the public.

There needs to be a single clear communication mechanism that reaches both the Hawaii public and visitors via a variety of sources including phone apps and texts. The public needs to know what is happening, the settings in which COVID-19 transmission is occurring, and be given clear guidance on the measures they can take to reduce transmission of COVID-19 among tourists, tourism workers, and the general public. The State of Hawaii and the tourism industry need to engage and enlist visitors and residents to maintain social distancing and to wear masks in public spaces. It is important for tourists to understand why they need to wear masks to protect tourism industry workers and the vulnerable in Hawaii. Passengers should be given the opportunity when they complete the travel clearance documents before departure to install an app on their phone that will notify them if they have been in close contact with an infected person while in Hawaii. Arriving passengers who did not install the app could be asked again to install it or face quarantine.

COMPREHENSIVE SCREENING

The purpose of our analysis is to minimize the number of incoming airline passengers infected with COVID-19 who disembark in Hawaii. It is critical that comprehensive policies be developed that address numerous other groups of people who regularly arrive in Hawaii. They include airplane pilots and related airplane crew, cruise ship passengers and crew, longshoremen moving from US mainland to ports in Hawaii, and moving between islands on commercial shipping. The airline and shipping industry have addressed this situation via standing orders to their employees, some of which involve quarantine during layovers in Hawaii. Currently our local pilots and crew, who continue to fly trans-Pacific flights and provide vital service, have been given strict guidelines by their respective airlines on how to disembark, eat, and sleep at foreign and mainland destinations without having to be tested or quarantined on return to Hawaii.

FUTURE TESTING PROTOCOLS

There is rapid development in COVID-19 testing that will greatly improve the accuracy of all types of COVID-19 tests. It is critical that we monitor developments and adapt the protocols proposed here as the situation evolves, an example of which would be new viral antigen tests. Antibody tests could also become part of a future testing protocol as more accurate tests emerge. Currently there is no COVID-19 vaccine. When a validated vaccine for preventing infection with COVID-19 becomes widely available, our recommendations will, of course, be modified.

TO MAKE HAWAII A COVID-SAFE DESTINATION, KEEP EXTERNAL INFECTIONS OUT

Quarantines to keep infected travelers from interacting with the community, coupled with stay-at-home orders, social distancing, and masking have reduced new COVID-19 infections in the Islands to a trickle. If Hawaii reopens to tourism, even at 20 percent of previous levels, hundreds of people with active COVID-19 infections can be expected to enter each month. This will make it hard, if not impossible, to maintain our success against this epidemic and may push us past the tipping point.

Currently discussed strategies of temperature and symptom screening without testing for active COVID-19 infection can only detect about a third of these infections. **A two-step strategy, combining fever and symptom testing with pre-flight RT-PCR testing, can cut these numbers by 80-90 percent.** At these reduced levels, an active testing, contact tracing and isolation program combined with continued social distancing and masking should allow us to maintain epidemic containment. Testing travelers coming to our Islands is essential to keeping us an attractive COVID-safe destination for tourists and to achieving a strong Hawaii economy.

SUPPORTING MATERIALS INCLUDING REFERENCES

Andres Hernandez, Esteban Correa-Agudelo, Hana Kim, Adam J Branscum, F. DeWolfe Miller, Neil MacKinnon, Diego F Cuadros (2020). On the impact of early non-pharmaceutical interventions as containment strategies against the COVID-19 pandemic. 2020. Last access on 7 June 2020. https://www.medrxiv.org/content/10.1101/2020.05.05.20092304v1.article-info.

Sang Il Kim, and Ji Yong Lee. Walk-Through Screening Center for COVID-19: An Accessible and Efficient Screening System in a Pandemic. J Korean Med Sci. 2020 Apr 20;35(15):e154 Last access on 8 June 2020. https://doi.org/10.3346/jkms.2020.35.e154

Tim Halliday (2020), The Hotel Room Tax Should be Raised – A Lot, *Civil Beat*, 17 May 2020. Last access on 8 June 2020. https://www.civilbeat.org/2020/05/the-hotel-tax-should-be-raised-a-lot/

Katelyn Gostic et al. (2020). Estimated effectiveness of symptom and risk screening to prevent the spread of COVID-19. *eLife* 2020;9:e55570 DOI: 10.7554/eLife.55570 Last access on 8 June 2020. https://elifesciences.org/articles/55570v1

Annelies Wilder-Smith, Calvin J. Chiew, and Vernon J. Lee (2020). Can we contain the COVID-19 outbreak with the same measures as for SARS? *Lancet Infectious Diseases*; 20: e102–07. Last access on 8 June 2020. https://www.thelancet.com/pdfs/journals/laninf/PIIS1473-3099(20)30129-8.pdf

RT-PCR screening sensitivity: Wenling Wang, Yanli Xu, Ruqin Gao et al. (2020). Detection of SARS-CoV-2 in Different Types of Clinical Specimens. *Journal of the American Medical Association*;323(18):1843-1844. doi:10.1001/jama.2020.3786 Last access on 8 June 2020. https://jamanetwork.com/journals/jama/fullarticle/2762997

RT-PCR screening sensitivity: Wei-jie Guan, Zheng-yi Ni, Yu Hu et al., for the China Medical Treatment Expert Group for Covid-19 (2020). Clinical Characteristics of Coronavirus Disease 2019 in China. *New England Journal of Medicine* 382:1708-1720. doi: 10.1056/NEJMoa2002032 Last access on 8 June 2020. https://www.nejm.org/doi/full/10.1056/NEJMoa2002032

H. Juliette Unwin, Swapnil Mishra, and Valerie C Bradley et al. State-level tracking of COVID-19 in the United States (21-05-2020), doi: https://doi.org/10.25561/79231. Last access on 8 June 2020.

Reference for daily cases in New Zealand: Ministry of Health, New Zealand. COVID-19 – current case details. At https://www.health.govt.nz/our-work/diseases-and-conditions/covid-19-novel-coronavirus/covid-19-current-situation/covid-19-current-cases. Last access on 8 June 2020.

Reference for daily cases in Japan: https://www.worldometers.info/coronavirus/country/japan/ Last access on 8 June 2020.

Reference for daily cases in South Korea: https://www.worldometers.info/coronavirus/country/south-korea/ Last access on 8 June 2020.

Jui-Yao Liu, Tzeng-Ji Chen, and Shinn-Jang Hwang (2020). Analysis of Imported Cases of COVID-19 in Taiwan: A Nationwide Study. *Int. J. Environ. Res. Public Health*; 17, 3311; doi:10.3390/ijerph17093311 Last access on 8 June 2020. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7246949/

CDC (2020). Interim Clinical Guidance for Management of Patients with Confirmed Coronavirus Disease (COVID-19). Last access on 6 June 2020: https://www.cdc.gov/coronavirus/2019-ncov/hcp/clinical-guidance-management-patients.html.

B.J. Quilty et al. (2020). Effectiveness of airport screening at detecting travellers infected with novel coronavirus (2019-nCoV). *Euro Surveillance*; 25(5):pii=2000080. Last access on 8 June 2020. https://doi.org/10.2807/1560-7917.ES.2020.25.5.2000080

Christina O'Connor, A look at Hawaiian Airlines' new cleaning and social distancing guidelines." *Pacific Business News*, 5 June 2020: p. 4. Last access on 8 June 2020. https://www.bizjournals.com/pacific/news/2020/06/03/hawaiian-airlines-adjustments-covid-19.html

Mzezewa, Tariro (2020). Airlines Say Everybody Onboard Must Wear a Mask. So Why Aren't They? *New York Times*, 4 June 2020. Last access on 8 June 2020. https://www.nytimes.com/2020/06/04/travel/coronavirus-flying-face-masks.html

Additional references on U.S. airlines' failure to enforce their own mask wearing policies.

- https://www.cnn.com/2020/05/13/business/airlines-mask-policy-enforcement/index.html Last access on 8 June 2020.

- https://www.reuters.com/article/us-health-coronavirus-airlines-masks-exc/exclusive-u-s-airlines-tell-crews-not-to-force-passengers-to-wear-masks-idUSKBN22O349 Last access on 8 June 2020.

- https://www.newsweek.com/airline-passengers-voice-concern-that-protective-mask-policies-are-not-being-enforced-1506613 Last access on 8 June 2020.

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