COVID-19 Rapid Response Impact Initiative | White Paper 21

Pandemic Resilience on Campus

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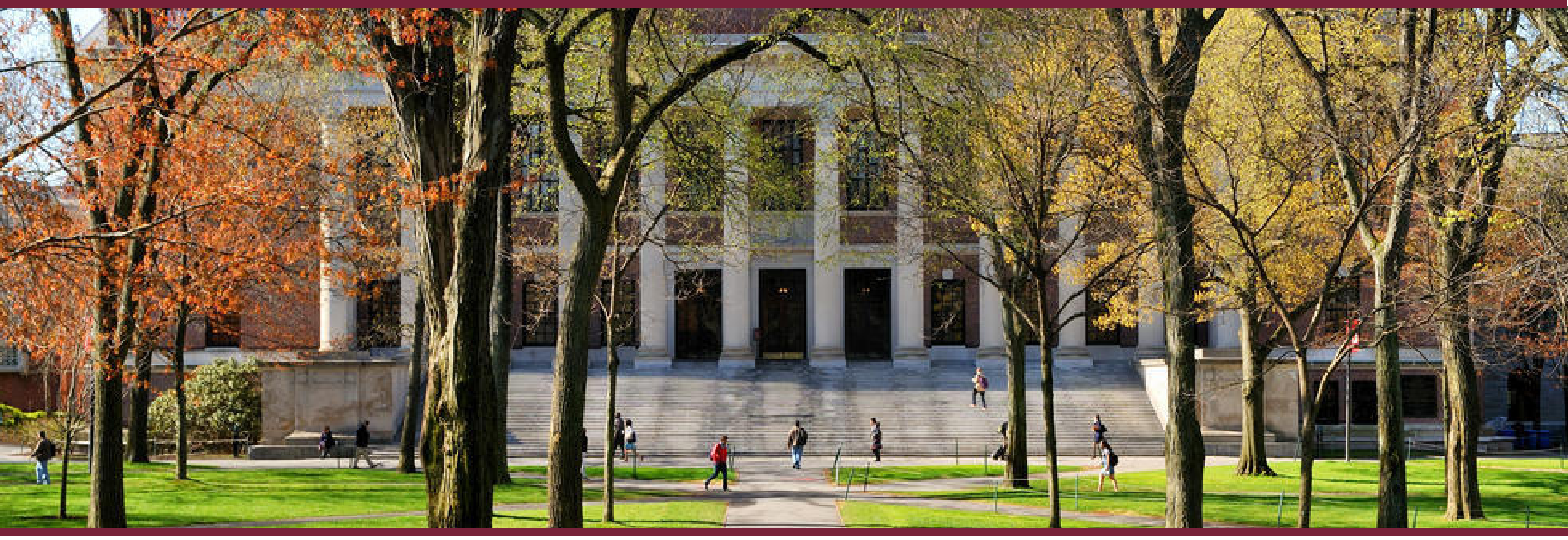

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Abstract

A college campus is a quintessential congregate environment with crowded and bustling living and learning spaces, vulnerable to rapid contagion. Yet online education as currently conceived is a poor substitute for the on-campus experience, and may exacerbate existing educational inequities. Many Colleges and Universities are accordingly keen to re-open their doors. In this paper we consider a range of criteria that must be considered as these decisions are made. In this process, institutions must look to and support the communities in which they are embedded, and determine whether disease prevalence outside their campuses allows for disease suppression within. We highlight that institutions must adopt not just population thinning, social distancing, and restrictions on mobility, as many are now preparing to do, but also that they need to build, maintain, and vigorously use an infrastructure for testing, tracing, and supported isolation. They need to demonstrate to students, faculty, and staff that they have little to fear from each other, and provide resources and care to those most vulnerable within their jurisdictions. If they can accomplish this, even with the delivery of classes having a significant online component, students may be able to safely return to campus life.

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01 Introduction

A college campus is a quintessential congregate environment. Its living spaces are about as densely populated as cruise ships and nursing homes, and its learning spaces as crowded as restaurants and call centers—all facilities that have been loci for the spread of disease.[7] In addition, campuses are embedded in communities, with relatively unrestricted mobility, so that campus health and community health are inexorably linked. This is especially the case for non-residential campuses, those located in urban areas, and those with a significant number of commuting students.

It's no surprise, then, that senior administration officials at institutions of higher learning face a wrenching choice. They understand that the makeshift online learning environment that was assembled in a hurry in March is unappealing to students (Jaschik, 2020) and ineffective in meeting their pedagogical mission. A critical element of this mission is to provide an equitable learning environment for those from a variety of socioeconomic backgrounds, which is considerably harder to do under the remote learning model (Casey, 2020). In addition, many students rely on institutions to meet basic needs, not just for educational purposes. Institutions that disproportionately serve these students are thus particularly motivated to reopen and provide a safe and healthy environment. But schools also must protect students, faculty, and staff, and are reluctant to risk major outbreaks of infection that are sure to generate chaos and suffering. Students are keen to get out of isolation and back to a more vibrant and stimulating environment surrounded by peers, and faculty are keen to deliver on their promises to educate and inspire. But the best path forward remains elusive.

In this paper, we consider the strategy laid out in the Safra Center's "Roadmap to Pandemic Resilience" (Allen et al., 2020b) and ask whether it may be possible to implement on a campus scale. The strategy involves a vigorous program of testing, tracing, and supported isolation (TTSI), as described in more

[7] See, for instance, Chang, 2020; Apuzzo, Rich, and Yaffe-Bellamy, 2020; Park et al., 2020; and Yourish et al., 2020.

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detail below. The roadmap outlined the manner in which this could be implemented on a national scale, and a supplement (Allen et al., 2020a) considered metropolitan level adaptations in response to varying local conditions. But implementation at an organizational scale poses unique challenges that will require tailored solutions. Schools that are not able to implement adequate safety measures and protect the health of those involved in campus life should commit to remote learning until they build up necessary capacity, as the California State University System has done (Hubler, 2020).

The purpose of this paper is to outline the critical factors that an institution will need to consider before deciding if, and under what constraints, it can safely reopen in the fall. There is no “one-size-fits-all” solution, but all institutions will need to consider the following factors. They will need to consider (and monitor) the case incidence of the disease on campus, as well as their capacity to test, trace, and isolate (with suitable support) their population. They will need to understand the extent to which local public health authorities can support their testing goals, and also the extent to which they can offer facilities to these authorities to support capacity in the broader community. They will need to reflect on their institutional mission, as it should guide trade-offs between competing choices. They will need to consider whether a phased return to campus is appropriate (akin to the phased reopenings that are happening in many states) and the public health indicators (both on campus and in the surrounding community) that will guide decisions to move between phases.

While plans will vary, depending on the variables listed above, as well as on the extent to which students live on campus in low density settings with social distancing contracts that they adhere to, ultimately the fate of the campus depends on the environment in which it is embedded. Hence we start with a look at disease case incidence projections for some major cities and counties.

02 The Surrounding Environment

Each week, a set of forecast models is submitted to the Centers for Disease Control and Prevention, and these are periodically evaluated for predictive accuracy as new data emerges. The best performing model (by far) is currently the one developed by a data scientist, Youyang Gu, who combines standard epidemiological models with machine learning tools used to uncover and update parameters. This model has outperformed not just each of the others, but has also beaten the ensemble average across all submissions in most weeks.

Since mid-May, Gu has been producing several county level forecasts, as well as a forecast for the five-county composite that is New York City. His model predicts new and cumulative deaths, and the reproduction number, as well as new, current, and total infections. Figure 1 shows forecasts (as of May 26) for prevailing infections for all dates until September 1, for New York City, Los Angeles County, Philadelphia County, and Cook County (which encompasses Chicago).

It is immediately clear from the figure that different cities are likely to be at very different levels of disease suppression as we approach the fall season. New York City, which was hit hardest in April, is predicted to be the safest in September, with fewer than 0.1 percent of its population infected on any given day. The predicted rates for the other counties are about ten times as great, ranging from 1.0 percent to 1.2 percent.[8] It is important to bear in mind, however, that the encouraging numbers for New York depend on assumptions about the pace at which restrictions on mobility will be relaxed over the coming months, and could change quickly and sharply as travel into the city picks up pace. The same is true for other major cities.

[8] Forecasts for many other counties are also available. These are predicted to have infection rates in early September that range from close to zero in Sacramento to 0.6 percent in Hillsborough, Florida. In Middlesex County, Massachusetts, which encompasses the city of Cambridge and is home to a number of prominent colleges and universities, the forecast is for 0.6 percent of the population to be infected at the start of September.

The Surrounding Environment

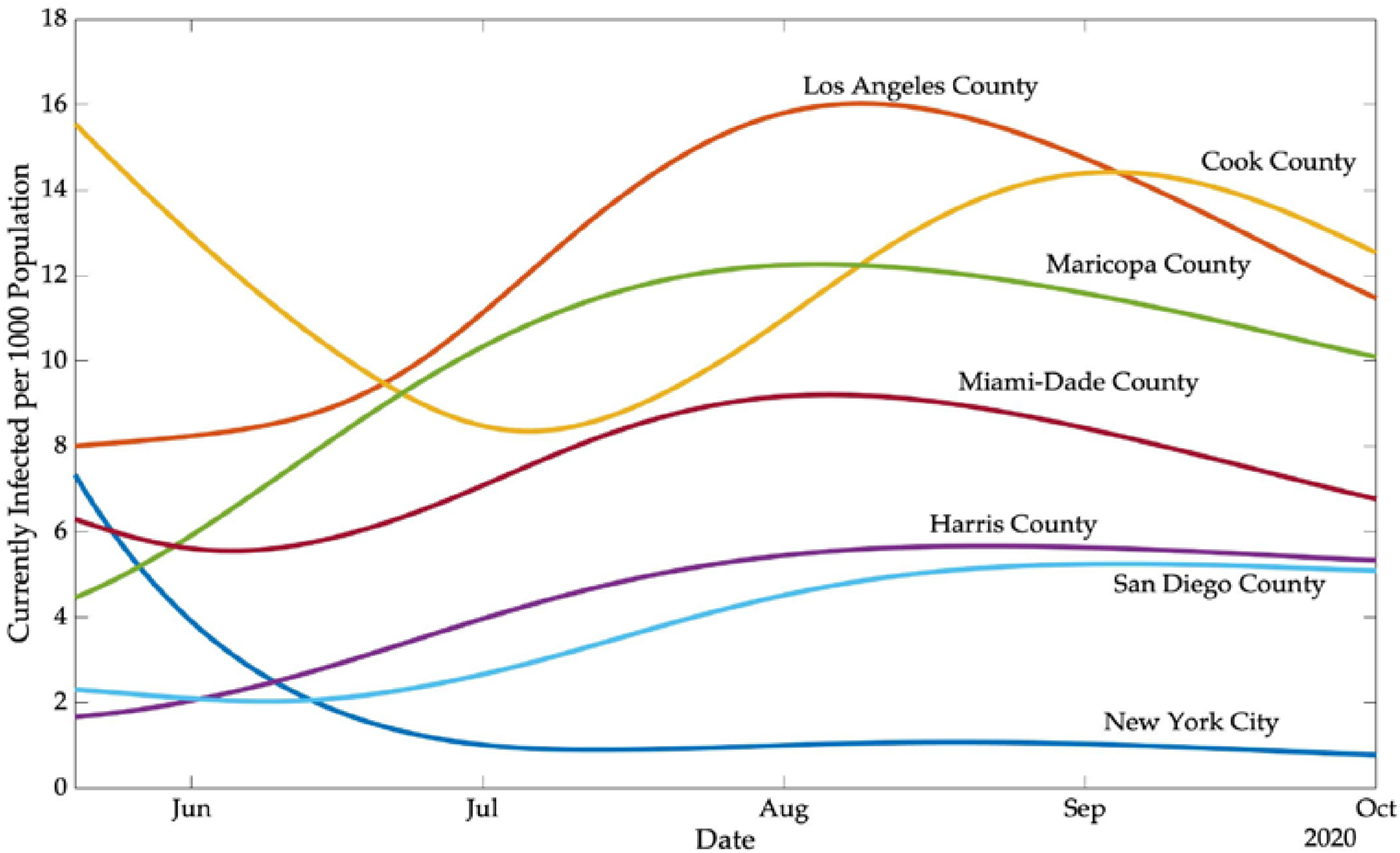

Figure 1. Past and predicted estimates of prevailing infections per 100K population, as of June 18, 2020. Data Source: Gu, covid19-projections.com

The predictions in Figure 1 are point estimates, and are contained within interval forecasts that reflect uncertainty. For instance, the interval forecast for current infections for New York City at the start of September ranges from 0 to 0.3 percent. For the other cities, not only is case incidence predicted to be greater but uncertainty about case incidence is also higher, reflected in wider interval forecasts. In Cook County, for instance, the upper bound of the interval forecast for prevailing infections in early September is 6 percent. That is, the differences in predicted case incidence across cities is extremely high even if one focuses only on highly pessimistic scenarios.

The Surrounding Environment

The point is that when making decisions on reopening, campus administrators will need to keep a watchful eye on projected conditions in the communities that surround them. What is possible for schools in the New York area may be out of reach for those in Chicago or Los Angeles. Similarly, schools in smaller towns and rural areas will find disease suppression easier than those in larger cities, but could also face greater challenges in the face of an outbreak, with limited medical facilities and resources within reach. Campus administrators will need to continue to monitor current and projected conditions and develop benchmarks for when it will be safe to move to a less restricted phase, and when it might be necessary to pull back and reinstate restrictions. New York State, for example, has developed a dashboard that makes it easy to see public health trends, and New York City has made both disease and antibody tests available free of charge to all residents.

Just as schools cannot isolate themselves from the towns and cities in which they are embedded, the communities around them cannot isolate themselves from the schools. A large influx of students from across the country (and international destinations if conditions permit) could have significant effects on the trajectory of disease case incidence, and on the community's capacity to respond to illness. In order for a school to reopen, therefore, a stringent program of testing, tracing, and supported isolation has to be in place on campus and in the community. This is particularly necessary when local communities may have limited or already overburdened medical and hospital capacity. A detailed guide for achieving this through testing, tracing, and supported isolation is laid out in the Roadmap to Pandemic Resilience (Allen et al., 2020b). Given their embeddedness and reliance on the surrounding communities, colleges and universities should consider advocacy and material support for this strategy in the broader environment to part of their own missions.

We consider the mechanics of this approach below, after first providing a brief overview of reopening plans that have been announced to date.

03 Current Plans

Many colleges around the country have already notified students and faculty of their plans for the fall, and these decisions show considerable variation. While some schools have pushed back their deadlines for prospective students to accept an offer (Dickler, 2020), they remain under pressure to settle on plans so that new and returning students can make informed choices.

According to the *Chronicle of Higher Education*, among the 740 colleges they are tracking, 65 percent are planning for an in-person semester in some form. Another 13 percent are either "considering a range of scenarios" or "waiting to decide," and just 8 percent are planning for a fully online semester. Notably, the California State University system, which has close to a half million students enrolled and employs more than 50,000 people, has announced that most of its classes will be held virtually in the fall (Madani, 2020).

Any school planning for a residential population has to consider how students, faculty, and staff will be kept safe. This will involve a program of extensive and repeated testing, coupled with public health education to encourage all community members to monitor their symptoms and present themselves to a testing center if they experience any of the common symptoms of the disease.

The University of California at San Diego is among the first to take concrete steps in this direction through its Return to Learn program. There are currently 5,000 students living on campus, conducting self-administered nasal swab tests that are being processed at a lab on campus. The program also involves collection of wastewater and surface samples in order to detect the presence of SARS-CoV-2. The school will provide isolation housing for students who test positive, and will implement contact tracing and exposure notification. If the program is found to be successful over the summer, the school will continue to adjust and scale-up the processes, with the intention to eventually cover the 65,000 students

Current Plans

and faculty in the UCSD community. Purdue is also planning for on-campus learning in the fall, with efforts to de-densify campus, establish a testing and tracing regime, require flu vaccination, and acquire and maintain a supply of protective gear.

Most campuses have assembled committees to determine the safest ways to reopen, and there is pressure to make decisions before July. One sign of concern is declining rates of federal aid applications among high-school seniors (Korn, 2020), indicating uncertainty among students about college attendance in the coming year. Thus, colleges need a coordinated and consistent plan to implement if they decide to pursue on-campus learning, and need to communicate their plan clearly so that students can make an informed decision about what their fall semester will look like. In the following sections, we evaluate whether the Roadmap to Pandemic Resilience can provide the template for such a plan.

04 The Roadmap

The Safra Center Roadmap to Pandemic Resilience lays out a strategy for dealing with COVID-19 on a national scale, focusing on a program of testing, tracing, and supported isolation. We first give an overview, and then consider each of these components in turn, and discuss how they can be adapted to the campus setting.

The roadmap starts from the premise that framing the problem we face as a choice between lives versus livelihoods is misleading and presents a false dichotomy. Lockdowns cannot be sustained for much longer both because they would be economically ruinous (Hubbard and Sethi, 2020) and because people will simply disobey stay-at-home orders on a massive scale, which may lead to outbreaks and fatalities, as is already evident. At the same time, any reopening that contributes to significant virus transmission will lead to great—and preventable—loss of life. An increased loss of life would create an additional drag on the economy as fear of illness and death keeps people at home even in the absence of stay-at-home orders. It is important to reopen in a manner that allows us to stay open, and this requires implementation of a TTSI strategy on a sufficiently large scale. For revival to be sustainable, people who return to economic and social life must have confidence that they are safe from each other, and that they can protect themselves and their loved ones.

The level of testing needed to accomplish this depends on the levels of case incidence of the disease. Suppression requires testing to be high. However, this need not be measured in relation to the population at large, and can instead be thought of in relation to the rate at which new tests are identifying new cases. To illustrate this point, consider Figure 2 (from Our World in Data, 2020), which shows daily tests per million population in relation to daily new confirmed cases per million population for South Korea and the United States (using a log scale on both axes). On June 18, based on a seven-day average, the United States conducted about 1,500 tests per million people, or about 500,000 tests in all.

The Roadmap

In comparison, Korea conducted only about 250 tests per million people, for a total of about 11,000 tests.[9] So it may seem that Korea is testing considerably less than the United States, both in absolute terms and in relation to the size of its population, and yet is able to sustain much lower levels of disease prevalence. How can it do this?

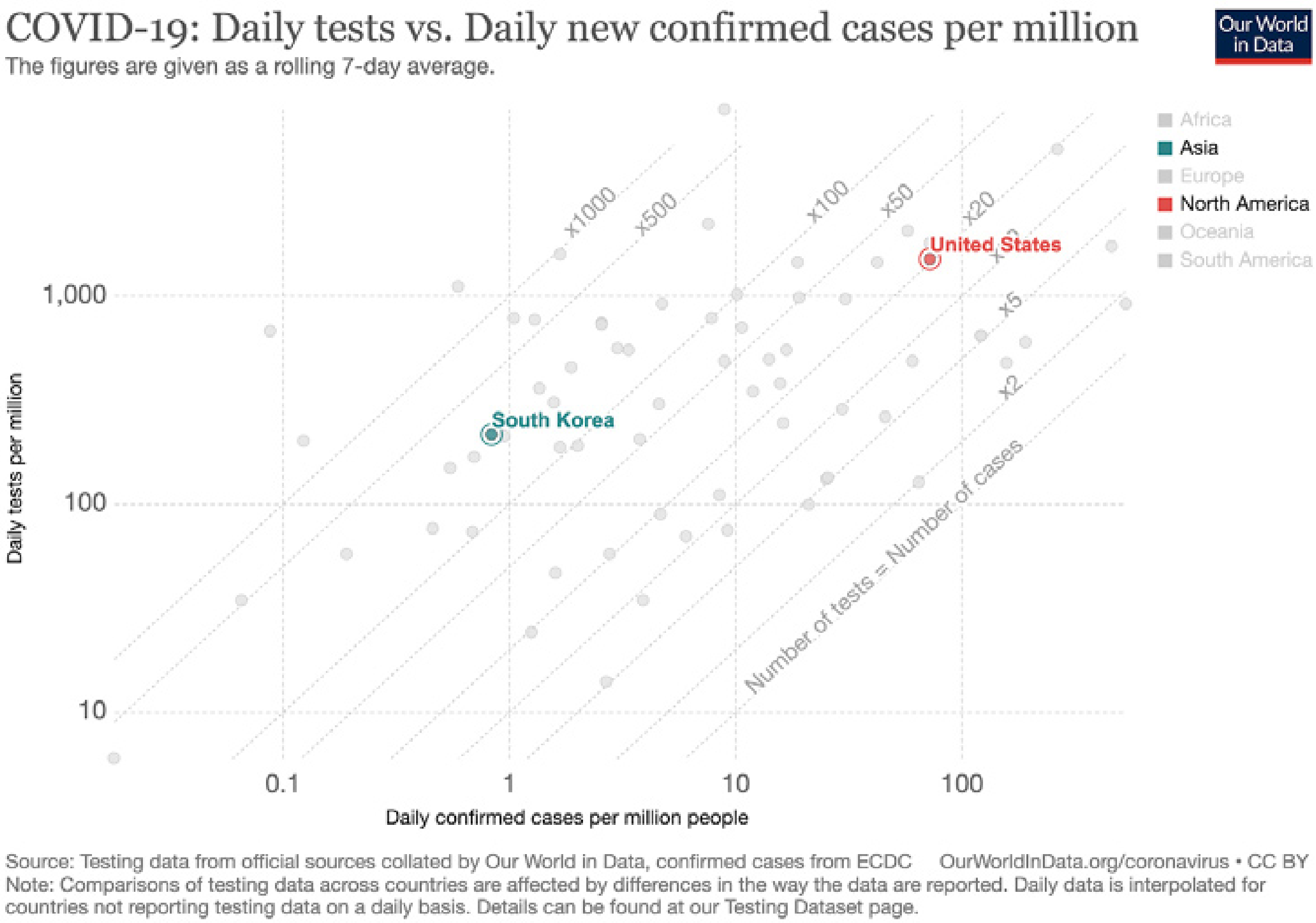

Figure 2. Tests versus New Cases in South Korea and the United States, per million population, log scale, as of June 18, 2020.

[9] Korea's population is about 52 million, while the United States has a population of about 328 million.

The Roadmap

Looking at tests relative to population is a very poor measure of the adequacy of testing levels; a more relevant metric is the proportion of tests relative to disease case incidence. And on this count, testing in the United States is grossly inadequate. Daily new confirmed cases were about 23,000 in the U.S. compared with just 280 in Korea (again based on a seven-day average). The ratio of tests to new cases was accordingly about 21:1 in the U.S., and over 250:1 in Korea.

What is true of nations and cities is also true of organizations and campuses: the scale of testing will need to depend on the rate at which tests are identifying positive cases. It is this positive rate that needs to be targeted, rather than the scale of testing relative to the campus population. If the positive rate is too high, it can be brought down by greater targeted testing, as described below, so that asymptomatic and presymptomatic cases can be identified and isolated quickly. But this still leaves unresolved important questions about the allocation of scarce testing resources across different subgroups of the campus population, the kinds of tests that are available and can be administered on the necessary scale, and a number of other logistical issues that we consider next.

05 Testing on Campus

In the nation as a whole, or even a metropolitan area, flows of individuals in and out are small relative to the size of the incumbent population. This is not true for most campuses, which are quite sparsely populated for long periods over the summer and then see a large and rapid influx of students, and often staff as well, just prior to the start of classes. That is, a campus situation with many new arrivals will initially be something of a blank slate in terms of existing caseload. Dealing with a newly assembled population that must be monitored, tested, and traced, rather than an existing population with known characteristics, requires a different approach.

If it is not feasible to test all returning students, initial testing could be disproportionately focused on those students arriving from communities with the highest infection rates. The same applies to faculty and staff: initial testing frequency could be conditioned on disease case incidence in the places where they reside, subject to data availability. New York City, for instance, is reporting data on case rates, death rates, and percent positive rates by zip code. Tremendous care must be taken, however, to ensure that privacy is maintained, that stigmatization of those testing positive does not occur, and that isolation is supported in ways that ways that minimize student aversion to testing in the first place. This is also true in the case of faculty, and importantly, staff, who may themselves be commuting from high-case incidence areas, and should also be supported with resources and protections.

Over time, better information about disease case incidence within specific networks on campus can be used to target testing resources. If the positive rate varies across dorms or majors for instance, testing frequency should be adjusted accordingly. Wastewater testing has been shown to be to be an effective leading indicator of outbreaks, and may provide a mechanism for determining which areas of a campus may have new cases emerging. As a general principle, targeting should be such that the likelihood of testing positive is roughly equalized across locations and networks (Allen, Weyl, and Sethi, 2020).

Testing on Campus

For instance, if one location is turning up more positive cases per test than another, resources would be better used by shifting to the former at the expense of the latter.[10]

What about the overall scale of testing necessary? At first, it may seem as if the estimates for maintenance-level testing in existing models suffice for this type of exercise. And this is largely true—the maintenance numbers pulled from best practices in successful countries like South Korea and Taiwan are highly relevant for a low- to no- case incidence campus. However, the high-contact nature of the space and a significant possibility of outbreak means that a population surveillance approach needs to be wedded to a TTSI-centric approach.

Here the strategy being pursued by UCSD may be instructive. The goal in the initial phase of the project is to test 10 percent of the residential student population per week, with a long-term goal of testing 60 to 90 percent of their entire population (students, faculty, and staff) per month. Their model predicts that if they can test this many people while the case incidence on campus is still less than 10 infected people per 60,000 community members, and couple that testing with contact tracing and supported isolation, they will be able to safely “return to learn.”

In the first two weeks of the program, UCSD demonstrated that the self-administered tests work and that their plans for coding and transferring samples functioned as planned. They are confident that their testing protocols will scale well and that the connections they have established between testing and public health interventions work. They are exploring various approaches to lower costs, and anticipate being able to bring this cost down to under $20 per test (current commercial rates are about $100 per test) (Fehr et al., 2020).

[10] The principle here is very similar to that used in outcome tests for discrimination in police stops and searches: differences across groups in contraband recovery rates (or hit rates) suggest a failure to optimize recovery rates and are thus interpreted as evidence of bias. Ayres, 2002.

Testing on Campus

However, the success of a testing program depends on the extent and speed of contact tracing. It is only through robust and agile tracing programs that true testing needs can be determined. A crucial piece of tracing is follow-up, through which traced contacts can quickly get tested and can isolate if need be. Thus, digital methods must be combined with quick turnaround follow-up to be successful at containment.

Regular random testing of a population enables detection of positive cases, ideally before the onset of symptoms when studies show that the viral shed is high. Many people, and especially the young, can have mild to no symptoms, making random testing particularly important in this population, in addition to the testing of contacts and contacts of contacts recommended under a TTSI framework. Easily administered tests with rapid responses would be best suited for a residential setting so that the time between testing and isolation for positive cases would be short. UCSD is using self-administered tests with a turnaround time of twenty-four hours.

Aside from random tests, mild cases can be identified sooner if students are provided with the necessary health education and are encouraged to monitor and report symptoms regularly. Loss of taste and smell is among the most common symptoms of COVID-19 (UCSD, 2020a), much more common than fever (Menni et al., 2020). Community members should be well trained to pay attention to such symptoms, self-isolate when they experience them, and be able to get quick testing before returning to more normal campus life.

Current tests use polymerase chain reaction (PCR) to amplify viral RNA. Nasal swab tests that need to be administered by health professionals wearing appropriate protective equipment are less suitable for a campus environment, but could be used if adequate health professionals were available. Turnaround time can be reduced by having a contracted lab nearby. University labs have already been instrumental

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in amplifying US testing capacity (Gluckman and Diep, 2020; Boyle, 2020), and schools considering reopening should look into whether they have the facilities to process tests on campus.

Saliva-based tests are much easier to use than nasal-based tests. The UK is planning a trial of saliva-based tests in the next few weeks on 5,000 people (Halliday, 2020). A preliminary study (currently under review) indicates that the saliva-based tests are more sensitive than the nasal tests (Wyllie, 2020). Curative, a California-based company that makes the kits, has said that they can produce 100,000 tests a week now and could expand massively if there were sufficient demand—demand that perhaps could be generated by guaranteed purchases by a higher-education compact.

Antibody testing, while requiring a blood draw, is now relatively easy to perform and at least in some communities, such as New York City, is freely available. However, antibody testing is not particularly helpful for making administrative decisions. It is highly unlikely that a campus would have the level of immunity required to effectively stop the spread of the virus, even in a hard-hit area like New York, given that most students will be arriving from other regions. However, individual students, staff, and faculty may take comfort in their antibody positive status and feel less fearful in the campus environment, and this makes these tests worth having on hand at a reasonable scale.[11] While the preponderance of scientific evidence from other coronaviruses supports the assertion that these individuals are unlikely to catch or spread COVID-19 for the next six months, there are no epidemiological studies yet that confirm that assertion. Recent information about the case incidence of positive antibody responses from pre–COVID-19 blood samples lends an additional cautionary note to the utility of antibody testing in public health decision making because a positive antibody test from a person who was never symptomatic may simply indicate a cross reactivity and not be indicative of any sort of immunity to SARS-COV-2 infection.

[11] Many jurisdictions, including New York City, are offering free antibody testing to all residents (NBC News, 2020).

Testing on Campus

Due to the high-contact nature of the campus environment, large-scale testing, tracing, and isolation is the only way emerging outbreaks can be quickly identified and prevented from spreading. Given the large numbers of tests required, as well as resource limitations, the testing of pooled samples will probably emerge as a particularly effective way of conducting a successful campus testing program in an environment where disease case incidence is low. If a pooled sample is positive, the samples must be disaggregated and retested, which saves time and expense only when positive tests are rare. Pooling samples is cost effective at a large scale, and requires fewer processing resources and less reagents. This method is ideal for campus testing, given that hundreds of students, faculty, and staff will need to be tested daily.

Campuses must be aware upfront of their capacity to conduct these different types of tests, as well as their capacity to ramp up testing if needed. Without a plan to conduct testing at scale, no matter the other precautions taken, it will be difficult for campuses to commit to protecting their students, faculty, and staff. However, we would again caution that without the ability to do appropriate testing and tracing, and to support the isolation of students, faculty, and staff, schools should commit to remote learning until capacity is achieved or risk levels are lowered. Determining how these tests should be allocated post-case identification will be through tracing, as discussed next.

06 Contact Tracing

Effective containment of the pandemic requires that people who have been in recent contact with anyone who tests positive for the virus be notified, tested, and isolated until the test results are received. Tracing and isolation must happen within twenty-four hours of infection being found to stall the spread. If possible, testing should be done within that time frame as well, so that second-level contacts of positive-testing initial contacts can then also be traced and isolated. This is one of the major challenges of returning to a residential college environment. The speed in which the contact tracing needs to be done is dependent on the degree of social density. In normal campus life, the number of people a student comes in contact with in a typical day can be very high. Adherence to social distancing is therefore critical for tracing and isolation to be effective. There is also reason to be concerned that eighteen- to twenty-two-year-olds will not adhere to social distancing guidelines. Public health education and approaches that treat students as thoughtful adults are likely to be more effective than punitive approaches, although even this may depend on campus culture.

Thus, contact tracing is an essential counterpart to widespread testing. Effective tracing may be particularly important on campuses where single-exposure events like parties and classes have the potential to infect large groups of people. Several approaches to contact tracing exist, with pros and cons widely discussed: manual methods based on interviews with patients, and smartphone-based methods using Bluetooth or GPS technologies to detect exposure events. Smartphone-based contact tracing apps have proven widely effective in Asia (Ghaffary, 2020) and are being developed in other parts of the world (Servick, 2020), but all effective methods to date have used a hybrid approach with a combination of digital and manual tracing. For maximum efficiency and coverage, we recommend having a professional manual tracing program combined with a Bluetooth-based tracing application recommended by the administration.

Contact Tracing

Contact-tracing apps are most effective when a single app covers a wide geographic area, and even in China where contact tracing apps were widespread (Xiao, 2020), confusion existed over the presence of multiple contact tracing apps, sometimes giving different answers. No central app has been adopted in the United States, although many cities and states have invested in their own contact tracing apps (New York City has not yet released a contact-tracing app, although it has partnered with Salesforce to develop one) (Higgins-Dunn and Feuer, 2020). Whether a contact-tracing app limited to a college campus would be effective or even feasible to develop is unclear—it would have a limited ability to detect contacts with non-college affiliates, but it may still be effective given the density of app-users in the campus environment. Several open-source apps exist today, including CovidWatch, CovidSafe, and MIT's Safe Paths, any of which could be adapted for use on a college campus.

Privacy of contact-tracing apps is also a major concern, and available apps vary widely in the degree to which they preserve user anonymity. Privacy is a function of both implementation and core algorithms. Since many of these apps are being developed in haste, universities adopting contact-tracing apps need to carefully vet their cryptographic security and data-handling practices. Core algorithms also vary widely in their approaches to user privacy: some apps upload sensitive user data to centralized servers, while others keep user data on their devices.

Contact-tracing apps use two primary methods: Bluetooth and GPS. These methods can be used in conjunction with one another. Bluetooth-based apps send out unique ID codes to nearby phones which also have the app installed. These ID codes are recorded and saved if the two phones are close together for an extended period of time. If a user is diagnosed with COVID-19, other users who have had extended contact with them can be alerted and directed to seek testing. This method has several key advantages: it is totally automated and completely anonymous. User ID codes are not tied to a specific username and can be frequently changed to protect privacy (Google, 2020a).

Contact Tracing

This Bluetooth method can be implemented in a minimally centralized fashion in which users upload no information to a central server. This is also a downside—the lack of identifiable and centralized information may hamper epidemiological evaluation on campus. Bluetooth-based methods also fail to detect potential contact through shared surface or interactions between users who do not have the same app installed. Apple and Google have developed an API for contact-tracing apps and have announced that they will deploy an opt-in contact tracing mechanism at the operating system level of iOS and Android devices. This means any user with an updated Apple or Android phone who opts into the program will participate automatically in a global contact tracing program.

The second common method is GPS-based, which can be used in addition to or in place of Bluetooth tracing. GPS-based methods, like MIT's Safe Paths app, track and record user movements using GPS and store them on the user's device. If a user is diagnosed with COVID, an anonymized version of that data is made public and other users of the app can see if their GPS trail overlapped with that of the infected user in the last few weeks. This gives more granular data about when and how contact occurred and enables high-resolution epidemiological analysis (Raskar, Pahwa, and Beaudry, 2020). However, GPS-based methods are more invasive. Because they track and share geolocation data, they raise substantial privacy concerns, present a more attractive target for hacking, and may be less readily adopted. Geolocation data is also difficult to anonymize effectively and sensitive or personal details can be recovered from movement patterns (Pérez-Peña and Rosenberg, 2018). GPS-based methods also perform poorly in interior or multi-floor environments like many college campuses (Mehaffrey, 2001).

Contact tracing can also be done in a far less technical, and often more privacy-preserving way using traditional interview-based methods. Anyone who tests positive will be asked to provide a list of places and people they have been in contact with in the last few weeks. These people can be called and notified to seek testing or interviewed about potential contacts. Universities have the opportunity to employ students or furloughed employees in some of these roles as contact tracers, helping to offset some of the economic hardship on university staff. However, privacy concerns among students may make this challenging. Manual, interview-based contact tracing is also challenging in a campus setting where students may not remember everyone in their classes or at a campus event. Tech augments to manual tracing, such as Maps history and scheduling, can be helpful in this capacity—and universities can, luckily, pull class enrollment lists to determine possible spread. Almost every student on campus keeps a smartphone with them at classes and events, so a Bluetooth method can precisely list, for example, students exposed at a party where manual tracing or GPS-methods would fail. This is one reason why automated methods may be more useful.

Still, given the technical limitations of digital tracing methods, no contact-tracing approach can be totally automated. A hybrid approach that leverages a single, privacy-conscious Bluetooth-based app like CovidWatch, CovidSafe, or the forthcoming iOS/Android contact-tracing update combined with phone and in-person interviews can preserve the privacy of university affiliates while stemming the spread of the virus.

07 Mobility, Density, and Supported Isolation

The whole point of returning to campus is to allow for better learning outcomes and a more vibrant social life. Social distancing regulations thwart this to some degree, while remaining necessary to contain the risk of an outbreak. But colleges will need to balance the trade-off between external and internal mobility restrictions: greater restrictions on external mobility can allow for more relaxed and enforceable rules within the campus community.

Even rural colleges have some degree of inflow and outflow, particularly among staff who commute to work from the surrounding communities. Cities in metropolitan areas have even more community interaction, with many students choosing to attend these schools precisely due to the amenities offered by an urban environment. Community colleges and other colleges with essentially no residential student population have a greater degree of inflow than exclusively residential four-year colleges. Traditionally, open campuses have prided themselves on their ability to attract guest speakers and entertainment, or to provide classes that involve a service or research component in the local community. These are all experiences that enrich college life. Nevertheless, it is clear that fewer interactions with the community will allow for more freedom within a protected environment.[12] Creating spaces in which non-residential students can work and access reliable high-speed internet and library resources may be a way to address student needs in scenarios where most learning remains online.

If disease suppression on campus has been achieved and maintained, large-scale population turnover—for instance around holidays—will have to be avoided. Given variation across the world in case incidence, a key factor will be mass movement in and out. Some schools are currently planning to end student presence on campus at the Thanksgiving Break (Kristoffersen, 2020), a time when many

[12] This may also be preferred by community leaders, especially if disease case incidence in the community is lower on average than in the places from which students are drawn.

would normally return home for a few days, and finish the semester with remote learning for all. Others are contemplating requiring students to stay on campus through the break, or stay home if they choose to leave. There might also have to be restrictions on even more commonplace movement. Schools will likely have to limit entry largely to students and staff, foregoing many traditional college events involving guests.

Not only must colleges secure their campuses from large or unnecessary inflows and outflows of people, but they must also reduce transmission risks within the protected campus environments. Social distancing requires thinning of living and learning spaces. In assessing campus spaces for transmission risk, it should be recalled that risk is a function both of exposure and time. In addition, risks may be higher in classes such as labs or studios where students and faculty have more prolonged and more intimate contact.

Among the spaces affected by social distancing guidelines are classrooms. Large lectures that congregate scores or even hundreds of students seated closely together are particularly high-risk and may have to be conducted virtually. A study recently completed at Cornell (Weeden and Cornwell, 2020) states that simply removing high-enrollment classes of 100 students or more from the network of a campus is insufficient for significantly reducing spread. Even when courses having more that 30 students are shifted online, a majority of students are connected to other students in four steps or less. One suggested proposal is to ensure that mean course size is approximately equal to the mean number of courses that a student takes, breaking up larger face to face courses into smaller sections and thus cutting transmission chains short.

In addition, while face-to-face instruction is certainly a primary vector of spread on campus, libraries and study or social spaces on campus also have to be reconfigured to meet social distancing guidelines,

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with chairs and tables placed suitably far apart. Dining halls pose a further challenge, because while students could wear masks in other campus spaces, this would be impossible to enforce while students are eating. Some possibilities would be expanding take-out options for dining halls or requiring reservations in order to adequately thin the amount of people in the cafeteria at a time. Many cities are considering allowing restaurants to reopen for outdoor dining due to the lower risk of transmission outdoors (Levenson, Parker-Pope, and Gorman, 2020), and cafeterias could consider providing this option, weather permitting. Cafeterias are a crucial part of campus life, particularly for students whose financial aid packages cover some portion of a consistent campus meal plan. If cafeteria food is to be restricted, other options will need to be provided for students, particularly those relying on subsidized meals.

One proposal for reducing contact within classes but still providing an on-campus experience is to allow some students to return to campus while keeping the majority of courses online. This model allows students to return to a stable environment well suited for learning, where they can interact with peers. The college environment provides access to adequate technology and learning resources and facilitates synchronous learning, something that is hard to do with students distributed across time zones.

Nowhere is population thinning possibly more crucial than in student living spaces. Ensuring both that dorms meet social distancing guidelines and that students and staff who test positive for the virus, or are identified as having been exposed to it, have appropriate facilities and support to strictly isolate on campus is one of the highest requirements for colleges to safely reopen. Furthermore, colleges should seek to make sure that quarantine does not pose a significant interruption to students' coursework, especially if they do not present symptoms, and that they can continue their classes virtually while isolating. Providing sufficient facilities for quarantine poses a major challenge for many college campuses, especially considering that in order to reduce population density many residential buildings will be operating under capacity. Attention to students' mental well-being while being quarantined is important as well—the prospect of being quarantined must not be a deterrent to a student's willingness to get tested.

On May 7th, the American College Health Association (ACHA) released a set of guidelines for colleges considering reopening (ACHA, 2020). They have recommended a single resident per room, and ideally to each bathroom as well. This may only be possible if the number of students living on campus is reduced or spread out across a larger time frame. They also recommend a requirement that face coverings be worn in common areas, frequent reminders of hygiene, frequent access to hand sanitizer, enhanced cleaning in all common areas and high-touch surfaces, appropriate PPE for custodial staff, public health trainings for residential administrators, restrictions on social activity along social-distancing guidelines, and restricted access to buildings by non-residents. Furthermore, campuses must ensure the safety of high-risk students who have health conditions that make them especially vulnerable.

Prior to allowing students back on campus, colleges must identify spaces where students who contract COVID-19 can isolate. This may be a specific residence hall or floor of a dormitory, but if there is not sufficient on-campus space, colleges may look into off-campus options. Some schools may coordinate with nearby hotels to provide rooms for students to quarantine. The ACHA recommends these rooms be stocked with a thermometer, sanitizing wipes, tissues, soap, hand sanitizer, and toiletries. There will need to be a system to deliver meals, medication, and hygiene supplies to students quarantining.

Faculty and staff, by virtue of their age distribution, are part of a higher risk pool when compared with students. Furthermore, the illness of faculty creates far more disruption to the learning process than unwell students, and few institutions have robust plans for replacing ill faculty members mid-semester. The possibility of having students live on campus while the majority of classes are held online would be one way of protecting faculty health. Resources could be directed at safely providing essential services to students (meals, housekeeping, health services) while instruction remains largely online with faculty continuing to isolate themselves from students.

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Colleges should also ensure that staff, particularly contract workers and other precarious positions, also have the support needed to isolate, including job protections and medical resources. These workers often fall through the cracks of campus policy, and may be at higher risk than students or commuting from high-risk areas.

Academic institutions vary in the scope and content of their missions. For some, research is among the highest priorities, and these organizations may prefer a reopening plan that preserves campus spaces for trained research staff while continuing the majority of classes online. For other institutions, teaching is paramount, and a critical goal is to level the playing field for students and provide an educational setting that both supports and challenges students from a diverse array of backgrounds. The pandemic has revealed how critical a physical campus can be to achieving this goal. Students who had to leave campus in the spring went home to vastly different lives (Casey, 2020), and some were not able to return home, whether it was due to travel restrictions, inability to afford a return trip, or the fact that they lived with immunocompromised or at-risk family members. At home, students have different access to a secure internet connection and devices for completing schoolwork, as well as having different household responsibilities, such as caring for younger siblings.

For schools that are deeply concerned about providing equitable access to learning resources, a residential population will be a high priority even if most classes are online and face-to-face contact with faculty is limited. Surveys suggest that most students want “a traditional college experience—living on campus, interacting with professors, studying and socializing with peers” (Hesel, 2020). But for this to happen safely, some scaled-down version of the testing, tracing, and supported isolation strategy outlined in the Roadmap to Pandemic Resilience (Allen et al., 2020b) will have to be implemented, in conjunction with population thinning, mobility restrictions, and innovations in pedagogy.

08 Conclusions

As the novel coronavirus spreads across the country (Thebault and Hauslohner 2020), it is becoming increasingly apparent that congregate environments such as prisons, nursing homes, and meatpacking plants have been critical loci of transmission. Most colleges and universities emptied residence halls and shifted to online classes in mid-March, otherwise they may well have been among the institutions most directly implicated in disease transmission. Like many other organizations, they face bleeding budgets, wrenching choices, and an inability to effectively fulfill their missions. They are desperate to return to some semblance of normalcy as soon as it is safe and practicable to do so.

But in making these decisions, they cannot simply look to each other for guidance. They must look instead to the communities in which they are embedded, and determine whether disease case incidence outside their campuses allows for disease suppression within. And if it does, they need to adopt not just population thinning, social distancing, and restrictions on mobility, as many are now preparing to do, but also a vigorous program of testing, tracing, and supported isolation. They need to demonstrate to students, faculty, and staff that they have little to fear from each other, and provide resources and care to those most vulnerable within their jurisdictions. If they can accomplish this, even with the delivery of classes having a significant online component, students may be able to escape the confines of isolation at home to return to campus life.

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